

Laparoscopic Treatment of Gastroesophageal Reflux Disease. Outcomes and Quality of Life. A Long Term Follow-Up Study.

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Rezumat

Tratamentul laparoscopic al bolii de reflux gastro-esofagian. Rezultatele pe termen lung și evaluarea calității vieții. Un studiu retrospectiv.

Context: Acest studiu evaluează fezabilitatea, eficacitatea, rata complicațiilor și rezultatele pe termen lung ale tratamentului laparoscopic al bolii de reflux gastro-esofagian (BRGE) într-un centru specializat.

Materiale și Metode: În perioada 01/11/1993 - 01/12/2019, au fost efectuate prin abord laparoscopic 620 fundoplicaturi conform tehnicii Rossetti și 160 fundoplicaturi conform tehnicii Toupet, însumând 780 proceduri pentru boala de reflux gastro-esofagian. Durata medie a intervenției chirurgicale a fost de 40 de minute (interval 19-160), 50 de minute (interval 30-180) pentru fundoplicatura Rossetti și 60 de minute (interval 45-190) pentru fundoplicatura Toupet. Toți pacienții au fost investigați prin radiografia tractului digestiv superior, esofagogastroscoapie, pH-metrie computerizată de 24 de ore, manometrie și scintigrafie pentru evaluarea clearance-ului esofagian și a timpilor de evacuare gastrică. Dintre cei 180 de pacienți (23%) cu hernie hiatală asociată, în 108 cazuri s-a efectuat hiatooplastie directă și în celelalte 72 de cazuri, hiatoaloplastie.

Rezultate: Nu au existat cazuri de mortalitate perioperatorie; rata de morbiditate a fost de 6,28%. Au existat 16,7% eșecuri pe termen lung, ce au necesitat reintervenție în 46 de cazuri (6,5%). 30 de pacienți (3,84%) au reluat terapia cu inhibitori de pompa de protoni (IPP) de 40 mg ocazional, iar 48 de pacienți (6,15%) au reluat terapia cu IPP de 40 mg continuu. Manometria la acești pacienți a relevat un tonus mai scăzut al sfincterului esofagian inferior, cuprins între 10 și 16 mm Hg, cu relaxări complete și coordonate.

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Dintre cei 44 de pacienți la care s-a practicat o a doua intervenție chirurgicală, 26 au fost reoperați pentru efectuarea unei fundoplicaturi mai strânse. 6 pacienți au necesitat reintervenție din cauza disfagiei. Au fost înregistrate 12 hernii paraesofagiene în grupul de pacienți la care s-a efectuat doar hiatoplastie fără proteză. În toate cazurile, s-a reintervenit laparoscopic pentru efectuarea unei hiatoplastii cu proteză.

Concluzii: Subliniem importanța evaluării preoperatorii precise, morfologice și funcționale a esofagului pentru selecția celei mai adecvate intervenții și a evaluării postoperatorii pentru determinarea cauzelor de eșec. În prezența herniei hiatale, este întotdeauna recomandată efectuarea hiatoplastiei cu plasarea unei proteze.

Cuvinte cheie: BRGE, laparoscopie, fundoplicație, urmărire

Abstract

Background: This study evaluates the feasibility, efficacy, the complications rate, and the long-term results of laparoscopic treatment of gastroesophageal reflux disease (GERD) at a dedicated center.

Materials and Methods: From 01/11/1993 to 01/12/2019, we performed 620 fundoplication surgeries by laparoscopic approach according to Rossetti technique and 160 according to Toupet technique, totally 780 procedures for gastroesophageal reflux disease. The average duration of surgery was 40 minutes (range 19 - 160) for Rossetti fundoplication, 50 (range 30 - 180), and for Toupet 60 (range 45 - 190). All patients were investigated by upper digestive tract radiography, esophagogastrosopy, 24h computerized pH-metry, manometry and scintigraphy to assess esophageal clearance and gastric emptying times. In the 180 (23 %) patients with associated hiatal hernia, direct hiatoplasty was performed in 108 cases, and hiatoalloplasty in the remaining 72.

Results: There were no cases of perioperative mortality; the morbidity rate was 6.28 %. We had 16.7 % long-term failures, requiring reintervention in 46 cases (6.5 %). Thirty patients (3.84 %) had to resume occasional 40 mg PPI therapy and 48 patients (6.15 %) had to resume 40 mg PPI therapy continuously. Manometry in these patients revealed lower esophageal sphincter tone between 10- and 16-mm hg with complete and coordinated relaxations. Of the 44 patients who underwent redo surgery 26 were reoperated to repackage a tighter plastic. Six patients required reoperation for dysphagia. Twelve paraesophageal hernias were recorded in the group of patients in whom only hiatoplasty without prosthesis was performed. In all cases, a hiatoplasty with prosthesis was repackaged laparoscopically.

Conclusions: We emphasize the importance of accurate morphologic and functional evaluation of the esophagus preoperatively for selection of the most appropriate intervention and post-operatively for evaluation of the causes of failures. In the presence of hiatal hernia, it is always advisable to perform hiatoplasty with the placement of a prosthesis.

Key words: GERD, laparoscopy, fundoplication, follow-up

Introduction

The minimally invasive surgery reflects its advantages in the context of fundoplication procedures for the treatment of gastroesophageal reflux disease (GERD), as recently

demonstrated in large series of patients (1,2). Surgery had previously demonstrated the superiority in long-term outcomes over protracted medical therapy (3). Among the various proposed fundoplication, Nissen's technique modified by Rossetti in 1977

appears to be the most performed and effective. Several studies showed that patients who underwent fundoplication postoperatively assess to Visick classes I - II in about 90% of cases (4,5). However, despite these satisfactory results, mid-and long-term morbidity and failure rates in the control of GERD are recorded in all case histories (6).

Literature points out that a careful preoperative evaluation of patients, and the consequent choice of the type of surgery to be performed, are crucial in obtaining an optimal outcome, minimizing the rates of recurrent symptoms and clinical signs of reflux. Endoscopic evaluation followed by functional investigations (esophageal manometry and pH metry) lead to adequate therapeutic choices and surgical approaches (7).

With the present study, we conducted a retrospective analysis of a case series of patients who underwent surgery for the treatment of gastroesophageal reflux disease (GERD) at our center, specifically evaluating perioperative morbidity and long-term outcomes.

Materials and Methods

From 01/11/1993 to 01/12/2019, we performed with laparoscopic approach 620 fundoplication surgeries according to Rossetti technique and 160 fundoplication surgeries according to Toupet technique, for a total of 780 operations for treatment of GERD. Associated surgeries were: 95 cholecystectomies, 12 liver biopsies, 2 liver nodule removal, 14 laparoscopic inguinal hernioalloplasties, and 70 adhesiolysis for previous surgeries.

All patients were admitted to the Department of General and Oncological Surgery - Policlinico San Marco - Zingonia - Italy. Informed written consent to participation in the study was signed and collected in all cases. The retrospective study, with anonymous data collection, was approved by the local ethics committee.

Inclusion criteria to the admission to the study were the following:

- Age > 18 years old;

- Presence of esophagitis at least of "A" degree at preoperative endoscopy and LES pressure < 12mmHg at preoperative manometry, with symptoms attributable to GERD;
- Persistence of GERD symptoms after at least 1 year of pharmacological treatment with proton pump inhibitors (PPI).

All patients were preoperatively evaluated with GERD - Q symptoms evaluation, upper GI endoscopy and X rays, esophageal manometry. pH-metry was performed in 598 cases (75.51%), mainly in patients with GERD signs and symptoms but borderline or not significant results at manometry.

Among the various proposed fundoplication, Rossetti-Hell's technique as described and published in 1977 (8) was the most performed in our experience. The operation consists of a 360° fundoplication that differs from Nissen's operation for the absence of the short gastric vessel section, the absence of the transfixion stitch on the esophagus, and the presence of one two gastro-gastric stitches. The procedure is conducted under general anesthesia with endotracheal intubation and assisted mechanical ventilation. The patient, to whom a nasogastric tube has been placed, is in supine decubitus and in a mild anti Trendelenburg position, with the legs spread apart. We do not apply the bladder catheter. The operating surgeon stands between the patient's legs, the assistant on his right, and an assistant operating the camera sitting on his left. The instrumentalist with the table is between the operator and the assistant. In contrast, the videolaparoscopic equipment is placed behind the patient's right shoulder. We use 5 trocars: two 5/11 mm and three 5 mm. Induced the pneumoperitoneum with introduction of the Verres needle 5 centimeters both cranially and to the left of the umbilical scar, after reaching an intraabdominal pressure of 15 mmHg, the first 5/11 mm trocar is inserted at the same site into which we introduce a 30° angled optic (which allows an easy and complete exploration of the abdominal cavity, better than that achievable with a frontal optic). In the left subxiphoid site, we insert a 5-mm trocar with a

stake for the purpose of lifting the left lobe of the liver. Three more trocars are then inserted: one 5/11 mm, on the left hemiclavicular line just below the costal arch, through which the operator will use the cutting, dissecting, hemostasis, and suturing instruments; another 5-mm trocar, on the anterior axillary line at the costal arch, is used to introduce a grasping forceps to grasp the stomach; the last 5-mm trocar, positioned in the right hypochondrium, will allow to maneuver a grasping forceps with the left hand. Having drawn the stomach downward, the Laimer-Bertelli membrane is incised on the apex of the hiatus with sparing of the gastro-hepatic and gastro-splenic ligaments and visualization of the left vagus nerve; instead, the gastro-phrenic ligament is dissected completely down to the retroperitoneum which allows the gastric fundus to be easily turned around behind the esophagus. Then by blunt dissection, and with the help of the pneumoperitoneum, the mediastinal space is penetrated and the right vagus nerve is identified and left posteriorly to avoid to encompass it in the fundoplication. After obtaining a wide passage into the meso-esophagus, a right-to-left grasping forceps is passed through it in order to grasp the gastric fundus and retract it to the right of the esophagus. Then grasping with forceps what will be the left and right margins of the fundoplication, the operator calibrates, after replacing the nasogastric tube with a probe between 40 and 60 F, the "softness" of the valve. According to the floppy Nissen technique we generally give three detached stitches with 2/0 nonabsorbable suture and extracorporeal knotting, so that the valve has a length of about 2 centimeters; according to Rossetti's modification, we do not include in the stitches the esophagus but fix with one or two stitches the left margin of the sleeve to the anterior wall of the stomach. To perform extracorporeal knot tying we use a pusher node made by us (9), with which normal surgical knots or self-locking slip knots, including the Roeder, can be quickly performed in an extremely simplified manner. In cases in which the hiatus is wide, we perform hiatoplasty with one or two stitches always knotted with extracorporeal technique. At the

end of the procedure, the nasogastric tube is removed.

All patients were preoperatively investigated by upper digestive tract Rx, esophago-gastroscopy, 24-hour computed pH metry, manometry, and scintigraphy in order to assess esophageal clearance and gastric emptying times. In 180 (23.68 %) patients a hiatal hernia coexisted, treated in 108 cases with hiatoplasty and in 72 with hiatoalloplasty.

All patients underwent upper GI X-rays on postoperative day 1.

The objective of the study was the evaluation of the feasibility and efficacy of minimally invasive primary and redo surgery for the treatment of GERD, with or without hiatal hernia correction, considering the data retrospectively collected from the long term follow-up of a large patient's series.

Follow-up was obtained by clinical evaluation after 1,3,6,12,24 months; all patients were telephonically contacted every year for a minimum period of 5 years after the surgical procedure in order to assess the recurrence of GERD symptoms, by using GERD - Q evaluation scores. All patients underwent endoscopy and upper GI X - rays 12 months after the operation. All patients with GERD symptoms recurrence and / or esophagitis recurrence at endoscopy and / or indication to restart PPI treatment underwent esophageal manometry and pH metry to assess the indication to redo surgery

Statistical Analysis

Statistical analysis with "chi - square" test was performed in order to evaluate significant difference in term of GERD recurrence among the 2 subgroups of patients treated with Rossetti and Toupet fundoplication.

Results

The present study included 780 patients (344 males, 44.10% and 436 females, 55.90%). Median age on admission was 48 years (range 24 - 72).

All patients underwent a follow-up of at least 5 years that was considered the minimum period necessary to obtain long term results; median follow-up period was 8 years (range 5 - 24).

The average duration of surgery was 45 minutes (range 19 - 160) for Rossetti procedure; 55 minutes (range 30 - 180) for Toupet. The average hospital stay was 2 days (range 1 - 4).

The laparotomic conversion rate was 0.51% (one case for pleural tear, one case for pericardial lesion, one for hemorrhage from the left phrenic artery, and one for peritoneal adhesions from previous laparotomic abdominal surgery).

No perioperative mortality occurred; perioperative morbidity rate of 6.28%; we report 30 cases of small incisional hernia at trocar site, 10 gas bloat syndrome, 9 esophageal perforations.

Of the 620 patients who underwent plastics according to Rossetti, 558 (90%) had an outcome rated 1-2 according to the Visik scale, a 62 (10%) an outcome rated 3-4 also according to the Visik scale. Among the 160 patients treated with a 180° posterior fundoplication according to Toupet, 124 (77.5 %) had a Visik 1-2 score, and 36 (22.5 %) a Visik 3-4. The difference between these 2 patient subgroups was evaluated by chi square statistical test, showing no significant difference.

The overall long-term gastro esophageal reflux disease recurrence rate was 16.7%. In 44 cases (5.64%) re-intervention was necessary.

Thirty patients (3.85 %) patients had to resume occasional therapy with Esomeprazole 40 mg and 48 patients (6.15 %) continuous therapy.

Among the 44 patients who underwent reintervention, a fundoplication according to Nissen was redone in 26 cases, and in 6 patients the anti-reflux fundoplication was disassembled due to dysphagia. We recorded 12 cases of GERD-related recurrence of hiatal hernia in patients who had previously undergone hiatoplasty; these patients were treated

with a redo procedure of hiatoalloplasty with mesh. After redo surgery, re-recurrence of symptoms was detected in 7 cases after 6 months of operation; in 2 cases it was due to re-recurrence of hiatal hernia, and 5 cases by persistent low LES function; all cases were treated with continuous PPI therapy without indications to re-redo surgery.

All data are summarized in *Tables 1, 2, 3.*

Discussion

Our experience demonstrated satisfactory results of laparoscopic surgery for the treatment

Table 1. Patients' demographic data and procedures

Patients number	780
Gender	344 M (44.10%) 436 F (55.90%)
Age	Median 48 yrs (range 24 - 72)
Procedures	620 Rossetti (79.49%) 160 Toupet (20.51%)
Associated procedures	95 Cholecystectomy 70 Adhesiolysis 14 Inguinale hernia repair 12 Liver biopsy 2 Liver nodule resection
Duration of surgery	Rossetti → Median 45 min (range 19 - 160) Toupet → Median 55 min (range 30 - 180)
Hospital stay	Median 2 days (range 1 - 4)

Table 2. Outcomes after surgery

Perioperative mortality	0%
Perioperative morbidity	6.28%
Postoperative GERD symptoms	
After Rossetti	Visik 1 - 2 → 90% Visik 3 - 4 → 10%
After Toupet	Visik 1 - 2 → 77.5% Visik 3 - 4 → 22.5%
	p: n.s.
Overall GERD recurrence rate	16.7%
PPI therapy restart rate	3.85%
Redo surgery rate	5.64%

Table 3. Results after redo surgery

Number of cases	44
Procedures	Redo Nissen → 26 (59.10%) Disassembling Nissen 6 → (13.63%) Hiatoalloplasty 12 → 12 (27.27%)
GERD re - recurrence rate	15.90%

of GERD (10). The laparoscopic technique is the most frequently performed because of its feasibility and effectiveness. In experienced hands, repositioning of intrathoracic valves, recurrent hernias repair, redo hiatoplasties, and various types of fundoplication can be performed with excellent results (11).

Analyzing the technical details, esophageal transfixion can cause endoluminal migration of the stitches, vagal injury, and esophageal wall lesions (12). The absence of the transfixed stitch between the valve and esophagus decreases the risk of anterior vagus nerve injury with possible consequences on gastric emptying; it also decreases the risk of fibrotic stenosis, which itself can be a cause of dysphagia. Indeed, it must be at least conceptually accepted that altered scarring and related adhesions may cause abnormal tractions and anchorages of the gastric esophageal junction and determine therapeutic failures especially in elderly patients with borderline manometry. Of particular interest is the possibility to convert a Rossetti-Hell fundoplication into a posterior hemifundoplication according to Toupet with a 45-mm mechanical suture. In fact, the lack of transfixion of the esophagus with the fundoplication stitches enables the introduction of the mechanical suture between the valve and the anterior wall of the distal esophagus (11).

Another technical detail to be analyzed concerns Rossetti's gastro-gastric stitch. In our opinion, this is an important detail in order to prevent the so-called "telescoping" i.e., the rising of the stomach through the fundoplication, a consequence that is sometimes observed considering that the fundoplication must be short and wide in accordance with De Meester's studies (13).

Regarding intraoperative complications, it should be specified that there are substantial differences between conventional and laparoscopic surgery. Laparoscopic surgery reports some specific complications such as pleural laceration that can lead to a hypertensive pneumothorax and pericardial lesions eventually causing heart tamponade. In contrast, splenic injuries, which are present in all laparotomy case

series, are very uncommon in laparoscopy. Complication related to technical mistakes, such as gastric and especially esophageal perforation, are also reported in Literature. In the observation of early postoperative complications, several cases of colon perforation are recorded, related to a mechanism of late burn necrosis due to improper or careless use of monopolar coagulation; the risk of these lesions is dramatically reduced by the employment of advanced coagulation/cutting systems such as ultrasonic dissector and radiofrequency (14).

The failure of laparoscopic surgery for GERD mainly consists of recurrence of reflux itself, recurrence or de novo onset of a hiatal hernia, or persistent dysphagia (15).

Negative outcomes can be related to a wrong surgical indication, incorrect preoperative functional study, inadequate choice of the technique, and technical mistakes determining a "poor quality" of surgery (16).

GERD recurrence with esophagitis is generally related to the partial or total rupture of a 360° fundoplication or to a non-adequate treatment of a co-existing short esophagus condition. In contrast, an intrathoracic migration of the fundoplication is not in itself a condition for GERD recurrence. The causes of intrathoracic migration of the valve may be: failure to close the diaphragmatic pillars, rupture of a posterior hiatoplasty (many authors also in the past have considered hiatoplasty, failure in correcting a short esophagus, as well as insufficient mobilization of the lower esophagus (17). Postoperative GERD recurrence can also be caused by two rare conditions: rotation and intragastric hernias. Rotation hernia is described by several authors after Nissen surgery performed according to the indications of De Meester (18). The mechanism by which such a hernia occurs can obviously be traced back to insufficiency or rupture of the hiatoplasty and the ascending of the fundus and part of the gastric body excessively mobilized by section of too many short vessels (19).

The most frequently described complication after laparoscopic fundoplication is persistent dysphagia (20). This inconvenience seems to be

almost exclusively secondary to the performance of a 360° antireflux valve. The Rossetti - Hell can lead to dysphagia more frequently than floppy Nissen. Most authors therefore emphasize the importance of dissecting the short vessels. In some cases, Rossetti's poor results can be attributed to technical mistakes (21). The critical technical point is the complete sectioning of the gastrophrenic ligament from the inferomedial portion of the left diaphragmatic pillar to the first short vessel. In cases of pathological reflux without hernia, Rossetti's technique also suggests, if necessary, to section only the medial part of the gastro splenic ligament, that contains the first two short vessels. Persistent postoperative dysphagia may thus be related to defects in surgical technique leading to a too tight valve (19). Persistent dysphagia may be secondary to purely functional problems. This is why an increasing number of authors emphasize the importance of esophageal manometry. It is essential to define the functionality of the esophageal body, studying amplitude and peristalsis of the contractile waves, as well as quantifying the lower sphincter pressure and establishing a correlation between esophageal peristalsis and the postoperative pressure that will be achieved. Only in this way would it be possible to identify patients unsuitable for a total fundoplication for whom it will then be more appropriate to provide a partial, preferably posterior, Toupet- or Lind-type plastic. An anterior hemivalve, Dor type, will have to be limited to a small number of cases, mainly elderly or with very severe motility disorders, or as an adjunctive operation to surgery of another type and notably after extramucosal myotomy according to Heller (22).

Regarding preoperative evaluation, special importance should be given to certain functional examinations such as scintigraphy and especially manometry. Only a correct and complete preoperative manometric study will highlight patients for whom a total fundoplication represents a high risk of persistent postoperative dysphagia. The

trend of large case series showing a progressive increase in the last 2 years of Toupet - or Lind-type fundoplication out of the total number of operations performed demonstrates an increasing attention to this delicate functional aspect. Therefore, emphasis is placed on the importance of accurate morphologic and functional evaluation of the esophagus pre-operatively for selection of the most appropriate intervention (23).

Recurrent reflux is the most frequent cause of failure and reintervention. Its incidence varies from studies depending on the duration of follow-ups, the inconsistent performance of postoperative pH-metry and endoscopy, and the diversity of clinical criteria used to classify symptoms as "clinically significant." The efficacy of fundoplication deteriorates over time, so results should be evaluated with follow-ups at least 10 years long (24).

Most case histories report 10-20% failure rates in the long term, and less than 10% in the short term. Others report higher failure rates, while Carlson, after an extensive review of the literature, reports lower ones (3.47%), but the follow-up was only a few months (12).

Some authors measure the failures of anti-reflux surgery with the percentages of patients who return to medication use, since one of the most frequent surgical indications is precisely the possibility of withdrawing from chronic medical therapy. According to Spechler, about 62% of operated patients return to regular anti-secretive medication in the long term (25) and Vakil reports 32% of patients taking heartburn medication 10-30 months after surgery (26). However, this evaluation criterion is rather fallacious when considering the reasons for so many prescriptions and self-prescriptions, including bloating, dysphagia, burning tongue, swollen and sore mouth. It has been reported that only one-third of patients taking medication for suspected reflux disease relapsed had pathological pH-metry.

To assess the actual incidence of relapsed reflux, some basic diagnostic elements must be considered. First of all, "heartburn does not

necessarily mean GERD". On the other hand, GERD is not always associated with heartburn. To check whether a heartburn is related to reflux, endoscopy will help us only if esophagitis is detected, whereas pH-metry will show the severity of reflux and its correlation with the symptom, albeit with its limitations in sensitivity and, to a lesser extent, specificity. The positive predictive value of the heartburn symptom is only 30-50% when compared with the results of pH-metry or with the presence of esophagitis.

A special type of failure is detected in asymptomatic cases with pathologic acid exposure at postoperative pH-metry. Anti-reflux surgery (as well as medical therapy) achieves symptomatic success in most patients, although a complete normalization of pH-metry is not always achieved. The negative predictive value of the symptom "heartburn" is 82-88%, which means that in the absence of symptoms 12-18% of patients have pathological pH-metry and a proportion of these also have esophagitis (27,28).

"Physiologic" failures are more numerous than "symptomatic" ones, since only a portion of patients with pathologic pH-metry are symptomatic. Zornig (15) reports positive pH-metry in 12.5% and esophagitis in 15% of patients at early postoperative follow-up, but many cases were asymptomatic.

The reintervention rate for recurrence was 9% in Arca's experience, 5% within the first 4 months in Zornig's (15), 0% in Holzinger's (16).

It is generally agreed that total funduplications are more effective, but discordant experiences have also been published. Zornig (15), after a randomized trial of 200 patients, reports that plastics according to Lindt are at least as effective as "lipsticks." However, the follow-up was only 4 months and, according to some authors, partial plastics over time lose effectiveness more than total ones. According to Zornig (16), the Rossetti suffer from a higher rate of hernial recurrence (resulting in reflux and/or dysphagia from diaphragmatic compression) than the Lindts, which are anchored to the diaphragm.

Other authors have reported very good

efficacy for posterior funduplications and equal comparisons between total and posterior ones.

Early recurrences are frequently caused by a technical defect. The most frequent causes of recurrence are anti-reflux plastic rupture and "peri-gastric" fundoplication. It is common to find more than one cause, especially the association of fundoplication unraveling, fundoplication slippage or ab initio wrong position, hiatal hernia recurrence. The rare form of para-esophageal herniation or slippage whereby the stomach herniates between the esophagus and the valve is associated with a lax or partially undone fundoplication.

Carlson, after a review of the literature on re-interventions published from 1995 to 2000, reports the following intraoperative findings: 36.3% hiatal hernias, 14% "slipped" funduplications, 12.8% undone, 10.6% "malpositioned" (oblique, low, twisted), 2.2% insufficient ("loose") (12).

pH-metry is essential in the absence of endoscopically documented esophagitis, but it is also recommended in all cases where surgical reintervention considered. Despite limitations in sensitivity and specificity, it is helpful in establishing the presence of pathologic acid exposure of the esophagus and the temporal correlation between the heartburn event and reflux.

Manometry detects whether the valve has low pressure values or is too short, but this is an invalid finding because a normal lower esophageal sphincter (LES) pressure does not rule out reflux disease and a hypotonic LES is not always related to GERD. According to Zornig (15) elevation of "nadir" pressure may be a cause, or a concomitant cause, of persistent gastroesophageal reflux at fundoplication. In case of "slippage," manometry may show an abnormal "ramp pressure" value and disruption of the peristaltic wave in the most distal electrode in the esophageal body.

If weakly acidic reflux (pH between 4 and 7) is suspected, pH-impedancemetry may help. If, on the other hand, alkaline reflux is suspected, which is very rare in unoperated stomachs, it can be documented with esophageal bilimetry, in addition to pH-metry.

In some cases, only surgical exploration can reveal an "anatomic" cause of recurrent reflux.

In most cases medical therapy is effective and therefore is the first choice, also because of the difficulty and risks of any reintervention.

Surgery is indicated if medical therapy is inapplicable or ineffective, in young patients and in good general condition, especially if recurrent reflux is associated with dysphagia or in the presence of important anatomical abnormalities that are technically correctable. In Stein's experience (29) reintervention was adopted in 52% of patients with reflux alone and much more often for those with reflux associated with dysphagia. If the association of reflux and dysphagia is caused by disintegration and slippage of the fundoplication, endoscopic dilatation is not recommended. Siewert (23) advises against reoperating patients with symptoms of recurrent reflux if severe motor abnormalities of the esophageal body are associated.

Reoperation often resolves the problem, even in cases without an obvious anatomic abnormality, but it must be performed by an experienced surgeon. Khan (22) reports 54% asymptomatic and 38% symptomatic but controlled by medical therapy in a case series of 26 reinterventions for recurrent reflux followed for an average of 8 years.

In reintervention cases, it is necessary to:

- Correct any anatomical defects (herniation, low or "slipped" fundoplication, absent-short-insufficient sleeve);
- In case of a recurrent hiatal hernia, reduce the herniation and perform the hiatoplasty, with nonabsorbable sutures or with prosthesis if indicated, leaving about 5 mm between the hiatus and the esophagus intubated by a 60 Fr probe;
- Correction of short esophagus; if not sufficient, a Collis gastroplasty and a fundoplication on the neoesophagus can be performed. A gastroplasty was required in 42% of reinterventions for recurrent reflux in Khan's experience (23);
- In the presence of inadequate surgery (His angle reconstruction, plastic sec. Dor

or Lortat-Jacob), convert to a total, posterior or postero-lateral fundoplication;

- Undo and redo the total fundoplication, 2-3 cm long, on a 48-60 Fr gauge, even if apparently corrected;
- Correct gastric delayed emptying (shunt, resection) (30).

Conclusions

Our experience, even with the limitation of the retrospective design of the study, demonstrated that the application of laparoscopy allows to achieve the surgical correction of gastroesophageal reflux disease with the advantages of a minimally invasive approach, with faster recovery and reduction of postoperative pain and hospital stay.

The minimally invasive approach can also be applied in specialized centers in cases of relapsed GERD, with satisfactory outcomes and low morbidity.

Conflicts of Interest and Source of Funding

The authors declare to have no potential conflicts of interest and did not receive any private or public funding.

Ethical Statement

The present retrospective study with anonymous data collection was approved by the local Ethics Committee.

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