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Surgical treatment of hiatal hernia: a ten-year experience

Desetogodišnje iskustvo u hirurškom lečenju bolesnika sa hijatus hernijom

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Abstract

Background/Aim. Today, hiatal hernia and the accompanying gastroesophageal reflux disease (GERD) are the most common benign disorders of the upper gastrointestinal tract. The aim of this study was to present the results of the hiatal hernia and GERD laparoscopic surgery in finding out for best type of fundoplication in each individual case. **Methods.** The study included 132 patients with the diagnosis of hiatal hernia and GERD, operated in the period from May 2004 to December 2014 at the Clinic for Abdominal, Endocrine and Transplantation Surgery of the Clinical Center Vojvodina, Serbia. The patients were selected for surgery on the basis of the findings of esophago-gastroscopy, barium contrast upper gastrointestinal series, 24-hour pH monitoring and esophageal manometric studies. **Results.** All the patients in this series underwent a posterior hiatoplasty with direct sutures. An additional mesh reinforcement was performed in 21 (16%) patients with a large hiatal hernia. There were 68 Nissen, 59 Toupet, and 5 Door fundoplications. Recently, the short-floppy Nissen fundoplication has predominantly been performed due to good postoperative outcomes. Intraoperative complications were: the parietal pleura lesion (3 patients), the spleen capsule laceration (4 patients), a minor injury of the adventitia of the distal esophagus (1 patient) and a thermal injury of the gastric fundus (1 patient). The postoperative complications were as folows: one fistula of the gastric fundus, transitory subcutaneous emphysema in the neck (5 patients), minor left-sided pleural effusions (6 patients), a transitory dysphagia (23 patients). The overall recurrence rate was 18.2% (24 patients). There was one fatal outcome. **Conclusion.** Laparoscopic surgery is considered a safe and effective surgical procedure for the treatment of hiatal hernia. The hiatal repair with a mesh reinforcement is recommended in selected cases. Today all consider the "short floppy" Nissen fundoplication as procedure of choice for the adequate hiatal repair.

Key words:
hernia, hiatal; surgical procedures, operative; surgical mesh; treatment outcome.

Apstrakt

Uvod/Cilj. Najčešći benigni poremećaji gornjeg dela gastrointestinalnog trakta u današnje vreme su hijatus hernija i pridružena gastroezofagusna refluksna bolest (GERB). Cilj rada bio je da se prikažu rezultati laparoskopskog hirurškog lečenja hijatus hernije i GERB u traženju najboljeg tipa fundoplikacije za svakog pojedinačnog bolesnika. **Metode.** Studijom su obuhvaćena 132 bolesnika sa dijagnozom hijatus hernije operisana u periodu od maja 2004. do decembra 2014. godine na Klinici za abdominalnu, endokrinu i transplantacionu hirurgiju Kliničkog centra Vojvodine. Selekcija za hirurško lečenje izvršena je na osnovu nalaza ezofagogastroskopije, rendgena gastroduodenuma sa kontrastom, 24-časovnog pH monitoringa i ezofagealne manometrije. **Rezultati.** Kod svih bolesnika izvršena je posteriorna hijatoplastika direktnim suturama, a kod 21 (16%) bolesnika sa velikom hijatus hernijom, uz direktnu suturu dodato je ojačanje mrežicom. Ukupno je izvedeno 68 Nissen-ovih fundoplikacija, 59 Toupet-ovih i samo 5 Door-ovih fundoplikacija. Zadnjih godina se uglavnom primenjuje „*short-floppy*" Nissen-ova fundoplikacija zbog dobrih postoperativnih rezultata. Od intraoperativnih komplikacija bile su prisutne: lezija parijetalne pleure (kod tri bolesnika), laceracija kapsule slezine (četiri bolesnika), minimalna povreda adventicije distalnog ezofagusa (kod jednog bolesnika) i termalna povreda

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fundusa želuca (jedan bolesnik). Od postoperativnih komplikacija zabeležena je jedna fistulizacija fundusa želuca, tranzitorni emfizem u predelu vrata (kod pet bolesnika), manji pleuralni izliv sa leve strane (kod šest bolesnika) i kod 23 (17,4%) bolesnika bila je prisutna tranzitorna disfagija. Stopa recidiva bila je 18,2% (kod 24 bolesnika). Desio se jedan fatalni ishod. **Zaključak.** Laparoskopska operacija se smatra bezbednom i uspešnom hirurškom procedurom u lečenju hijatus hernije. Hijatoplastika ojačana mrežicom preporučljiva je procedura u odabranim slučajevima. Posle adekvatne hijatoplastike preporučuje se primena dobro mobilisane „*short flopy*" Nissenove fundoplikacije.

Ključne reči:
hernija, dijafragmalna; hirurgija, operativne procedure; hirurška mrežica; lečenje, ishod.

Introduction

Hiatal hernia (HH) and the accompanying gastroesophageal reflux disease (GERD) are the most common benign disorders of the upper gastrointestinal tract all over the world nowadays [1]. Due to a constantly increasing prevalence of these diseases, there is a growing number of studies and papers in literature. Earlier, these disorders were predominantly treated conservatively, applying diverse diets, antacid drugs, specific H2-receptor blockers, proton pump inhibitors etc. and a surgery was considered only in case the former measures were ineffective. However, larger HH with a severe reflux and the assumption that GERD and subsequent Barett's esophagitis may induce cancer significantly contributed to a better understanding and more efficient treatment of this disorder [2, 3]. Furthermore, all these facts contributed to extend the scope of indications significantly and more readily decide to perform a surgery.

The treatment strategy both for the patients with GERD and those with HH has been significantly modified in a few recent decades due to anti-reflux surgery which is performed laparoscopically. Laparoscopical approach has considerable advantages as compared with the open, conventional surgery and it enables Nissen fundoplication with a minimally invasive trauma and significantly reduced postoperative sequels [4, 5]. Due to a reduced morbidity, good results and well-known advantages of laparoscopic approach, an increasing number of GERD patients are selected for surgical treatment. Nissen (complete fundoplication) or Toupet (partial fundoplication) have soon become the procedures of choice in the surgical treatment of the patients with GERD-accompanied by HH. The standard Nissen fundoplication was accompanied with a higher morbidity rate as well as with dysphagia and postprandial bloating. Partial Toupet fundoplication was mainly reserved for the patients with slow pulsating motions on the manometric analysis and this fundoplication type was associated with a lower morbidity rate. Since 2009, the choice of fundoplication has been modified, favoring the Nissen *short-floppy* fundoplication.

The aim of this study was to present performed fundoplication types in the patients operated on for HH and accompanying GERD at the Clinic for Abdominal, Endocrine and Transplantation Surgery of the Clinical Center of Vojvodina, Serbia, in order to find out the best type of fundoplication in each individual case.

Methods

Data source and clinical trial design

A retrospective, single-arm, observational trial was conducted from May 2004 to December 2014. The Institutional Review Board approved this study in compliance with all applicable federal regulations in February 2015 (No 33/15). Study participants were recruited from the patients who underwent surgeries in the hiatal area. Informed consent for this study was not obtained from each study subject because of a retrospective nature of the study.

Study population

Adult male patients and nonpregnant female patients (18 years of age or older) admitted and operated on for any elective surgical procedure in the hiatal area were eligible for this trial. Those having the diagnosis other than HH, other than GERD with or without HH (especially achalasia) were excluded.

Patients having access to the peritoneal cavity other than laparoscopy, those with incomplete medical data, and those who did not fullfilled the required 12-month telephone follow-up (including those who died during that period) were excluded.

Study interventions

Study participants were scheduled for laparoscopy before study enrollment. Demographic, medical history, laboratory, perioperative, operative, and surgical outcomes data were collected retrospectively from medical records.

Demographic variables included age, gender and body mass index (BMI). Medical history data included preoperative risk assessement using American Society of Anaesthesiologists (ASA) score, preoperative GERD symptoms evaluation (heartburn, regurgitation, postprandial dysphagia, anaemia, chest pain, vomiting, cough and dyspnea), preoperative assessing the type of HH (obtained from diagnostic studies), hystory of diabetes, history of smoking, preoperative functional and morphologic studies and surgical indications. Laboratory parameters recorded at the time of operation included hemoglobin, white blood cell count, blood urea nitrogen, bilirubin, and total protein level. Perioperative and operative data collected included antibiotics and/or antico-

agulants administered within 1 hour of operation, operative time, intraoperative confirming of preoperative assesing of HH size, need for conversion in laparotomy, intraoperative transfusion (mL), type of the used procedure in historical phases, use of prosthetic material, use of peritoneal drains and intraoperative complications. Surgical technique was given in brief. Surgical outcomes and follow-up data included length of stay, postoperative in-hospital and outpatient complications and postoperative telephone follow-up time.

Follow-up

All study subjects were clinically and by telephone followed up for a minimum of 12 months for recurrence and adverse events including dysphagia, distention, epigastric pain, heartburn and belching by gastroenterologist and surgeon. The follow-up data, including the final telephone questionnaire, was collected by personnel blinded to the surgical procedure performed. Patients were followed up 6 month and 12 month and symptom questionnaires were completed at these phone call visits for all contactable patients. The information obtained with this questionnaire included symptoms, recurrence and Visick questionnaire. Out of the 218 patients who were screened for this study, 86 were excluded. There were 132 evaluable patients who represented the study population for this analysis. Telephone follow-up was continued later only for reccurence.

Surgical treatment

Indications for the surgical treatment in the patients with HH (paraesophageal or mixed type) were established on the basis of the upper endoscopy findings (esophagogastroscopy), upper contrast (barium) gastrointestinal series in the Trendelenburg position and 24-hour pH manometric studies in the GERD patients. Esophageal manometric studies provided useful information about the motor activity of the esophageal body, assessing the quality of the esophageal peristalsis. The values of the esophageal manometric studies over 12–16 mmHg allowed a safe Nissen fundoplication, while lower manometric studies values, due to a failure of the esophageal propulsion, suggested that the Toupet fundoplication should be performed.

All the patients had an adequate preoperative preparation for the elective surgical operations and were admitted to hospital a day prior to the scheduled surgery. All operations were performed in the elective surgery program in general anesthesia. Prophylactic doses of antibiotics (second generation cephalosporines) were administered to all patients one hour before the surgery. All patients were placed in the reversed Trendelenburg position on the table inclined at 20°–25°, with separated legs. The surgery started by induction of pneumoperitoneum, placing a supraumbilical port for the optics and another four working ports (two 10 mm and two 5 mm *in situ* respectively) to enable the most flexible manipulation of atraumatic forceps. A surgical exploration was always performed first, followed by a careful dissection. Having the total dissection performed, a posterior crural repair was routinely performed in all cases, with three or four non-absorbable interrupted sutures Ethibond® 00. In the large paraesophageal HH, with the crural defect of 4–6 cm or more, the posterior crural repair with interrupted sutures was reinforced with a mesh in the assymetrically "U" or a key-hole shape. We applied a dual, two-component Proceed® mesh. It was placed behind the esophagus and fixed with a few extracorporaly sutures Ethibond® 00 (Figure 1). The selected fundoplication type followed. In the first several years (2004–2005), predominantly performed standard procedure was the ordinary Nissen fundoplication. Due to threatening postoperative complications, such as dysphagia and bloating with the symptoms of stenosis which usually required a re-operation, this fundoplication type was soon (after the 3 years, in 2006) replaced by the partial Toupet fundoplication. In the last few years (2010–2014), due to a high relapse rate, the choice of fundoplication was predominantly based on the "short-floppy" Nissen fundoplication preceded by a complete mobilization of the gastric fundus and a part of its corpus with cutting of short gastric vessels, reducing the wrap length to 2 cm. The Toupet fundoplication was performed only in patients with significant esophageal motility disorders registered at manometric studies.

The primary outcomes variable was the noted surgical outcome one year after the operation.

Secondary outcomes variable was only recurrence noted by telephone follow-up later than one year.

Sample size was not calculatated because of single-arm retrospective observational study that included all eligible subjects.

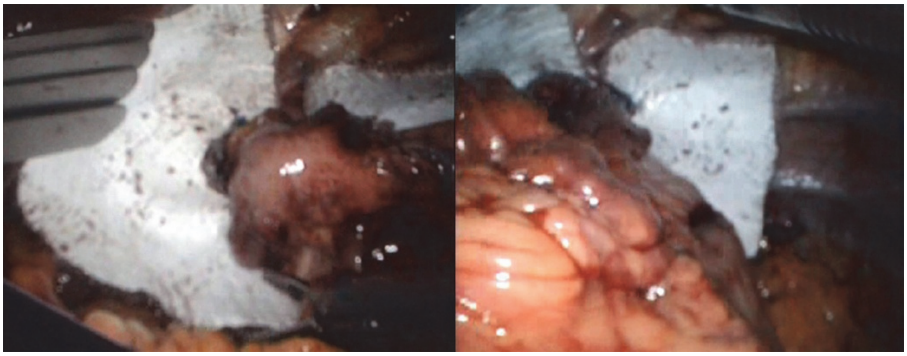

Fig. 1 – Display of the hiatal repair with a mesh reinforcement.

Statistical analysis

Results are expressed in descriptive manner only with basic statistical parameters.

Results

Patient characteristics

The study population was operated by a surgery team, consisting of 4 surgeons, at the Clinic for Abdominal, Endocrine and Transplantation Surgery from May 2004 till December 2014. Medical records of all patients having an operation in hiatal region were screened and enrolled in the study in May 2015. A total of 218 patients were enrolled in the trial and 86 were excluded. They were excluded because of an access to peritoneal cavity via laparotomy (n = 48), diagnosis of achalasia (n = 22), carcinoma of cardia preoperatively undiagnosed (n = 1), mortality (n = 1), incomplete data (n = 6), incomplete six-months follow-up (n = 6) and because of incomplete twelve-months follow-up (n = 2). Then, 132 patients were followed up for adverse events minimum 12 months. Statistical analysis included these 132 patients. The flow of participants through each stage of the trial is demonstrated in Figure 2.

Over the mentioned period there were 132 patients who underwent a laparoscopic surgery at the Clinic due to a diagnosed HH without GERD (solely HH) in 10 (7.6%) patients, due to diagnosed GERD without HH (solely GERD) in 12 (9.1%) and diagnosed HH accompanied with GERD in 110 (83.3%) patients. The study population was composed of twice more women than men (88 or 66.7% *vs* 44 or 33.3%, respectively) with a mean age at presentation of 56.04 ± 13.47 years (ranging from 26 to 78 years). Mean body mass index (BMI) for the study population was 25.6 ± 13.5 kg/m^2. Nearly half of the patients in this study 58/132 (43.9%) were overweight BMI (> 25 kg/m^2).

Types of hiatal hernia

All patients had clear documentation regarding the type of hernia. On the basis of the obtained findings, X-ray screening visualized a larger hiatal hernia in 23 (17.4%) patients. HH types were assessed preoperatively with endoscopy and upper gastrointestinal contrast series and finally confirmed at the operation.

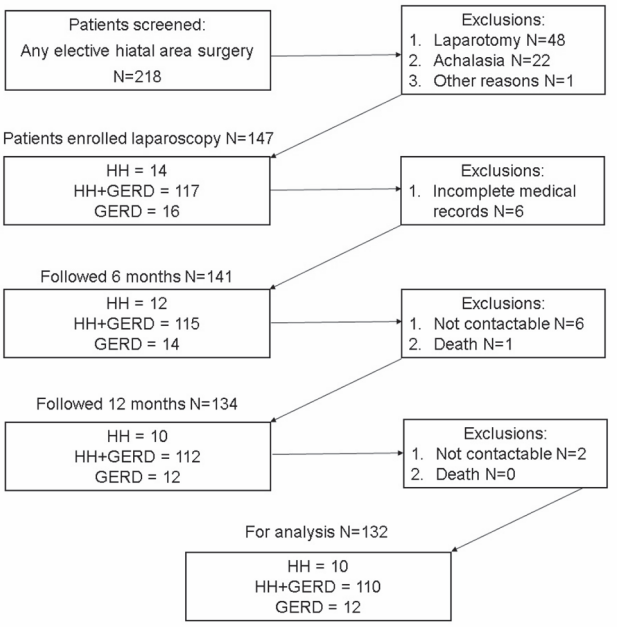

Fig. 2 – The flow of participants through each stage of the trial. HH – hiatal hernia; GERD – gastroesophageal reflux disease.

Twenty-three (17.4%) patients had the so-called large HH, which was intraoperatively in the diameter of ≥ 5 cm between the crura, or, over one half of the stomach was localized in the hernial sac, intrathoracally. Type I (paraesophageal), type II (sliding) or type III (mixed) HH was registered in 39 (29.55%), 57 (43.18%) and 36 (27.27%) patients, respectively. Only one female patient had an extremely large HH involving the whole of the stomach, a part of the colon, a few small intestine loops and most of the omentum in thorax. Some authors consider this to be type IV HH, occurring rarely [6].

Diagnosis

The major symptoms registered in our patients included: heartburn, regurgitation, postprandial dysphagia, anemia, chest pain, vomiting, cough and dyspnea. HH symptoms registered in our examined patients are reviewed according to the HH type in Table 1. The most common symptoms correlated to those were characteristical for GERD.

Table 1

Clinical preoperative symptoms*

Major clinical symptoms	Type I	Type II	Type III	Total
Heartburn	25	43	29	97
Regurgitation	21	41	25	87
Postprandial dysphagia	15	24	14	53
Anemia	4	3	2	9
Chest pain	10	12	5	27
Vomiting	7	15	3	25
Cough	5	10	4	19
Dyspnea	2	5	2	9

***All data are expressed as number of patients.**

Esophageal manometric studies established a reduced function of the lower esophageal sphincter (LES) and the esophageal body in 72 (54.5%) patients, and pH monitoring revealed a pathologic exposition of the esophageal acid into the distal esophagus in 39 (29.5%) patients and 12 (9%) patients had a clearly established "Barrett`s esophagus" due to HH-induced GERD.

The preoperative risk was assessed using the American Society of Anesthesiology (ASA) Score System. The ASA I score was registered in 18 (13.7%) patients. Most patients – 85 (64.4%) had the ASA II score and the remaining 29 (21.9%) patients had the ASA III score. The incidence of diabetes mellitus was recorded in 21 (15.9%) patients. Active tobacco use was reported in nearly half of the study patients – 64 (48.5%).

Mean serum leukocyte, hematocrit, blood urea nitrogen, total protein, and bilirubin levels were 12.5 ± 7.6 x 10^3/L (range 3.6 to 10.0 x 10^3/L), 38.7% ± 6.3% (range 38% to 49%), 6.4 ± 4.8 mmol/L (range 1 to 7.5 mmol/L), 6.44 ± 0.76 g/dL (range 6.0 to 8.0 g/dL), and 0.708 ± 0.766 mg/dL (range 0.2 to 1.23 mg/dL), respectively.

Surgery

Preoperative prophylactic antibiotics and preoperative venous thromboembolism prophylaxis with heparin were administered to all patients in this study. The average length of surgery was 103.4 ± 28.7 (ranging 60 to 160) minutes when performing the hiatal repair only by direct suturing or 20 minutes longer when applying a mesh. Intraoperative confirming of preoperative assesing of hiatal hernia size are mentioned in the section of patient characterisctic.

Eleven (8.3%) patients underwent a conversion into the upper laparotomy; in 9 patients it was predominantly due to adhesions of former surgeries and in 2 patients due to an excessive hemorrhage induced by the injuries of the spleen capsule in one case and by inadequately cutting of branch of the short gastric arterial vessels in the other, respectively. The mean blood loss was 60 mL (range, 0–800 mL). Two patients had 500 to 800 mL of blood loss. In the selected cases with a large HH [21 (15.9%) patients] a mesh reinforcement was performed. Use of peritoneal drains were noted in all patients.

Intraoperative complications

The parietal pleura was injured in the course of the circular peeling and esophageal preparation in 3 patients with larger hernias. The complications occurred in all 3 patients resolved by laparoscopical suturing and aspirating the pleural space with the assistance of an anesthesiologist who inflated the lungs with no need for thoracic drains. Minor laceration of the spleen at the greater omentum adherence site to the spleen capsule occurred in 4 patients. In 3 of them, hemostasis was achieved laparoscopically by ultrasound scissors, inserting the Surgicel® patch, while the fourth patient had a conversion to laparotomy due to excessive bleeding and since hemostasis was impossible to achieve, splenectomy was performed. One patient had the adventitia of the distal esophagus injured and the complication was resolved by laparoscopical suturing with two intracorporeal sutures. During the gastric mobilization, one patient had a thermal injury of the gastric fundus when cutting the short gastric vessels with ultrasound scissors. In the postoperative course, on the 9th postoperative day, this patient developed a fistula with signs of the intraabdominal abscess and excessive pleural effusions, confirmed on abdominal CT scans. The patient underwent a reoperation with midline upper laparotomy, abscessotomy and excising the damaged gastric fundus by a linear stapling device.

Surgical outcomes and follow-up data

The average length of stay was 3.8 ± 2.7 (ranging from 2 to 19) days. Three patients stayed 10 to 19 days for various reasons including chronic obstructive pulmonary disease-related symptoms, postoperative pain, and postoperative pleural effusion. Average time of recurrence presentation was 9.2 ± 12.8 months. The follow-up period ranged from 6 months to 6 years and 4 months.

Postoperative complications

Regarding the postoperative complications, one fistulization occurred at the site of the thermal damage of the gastric fundus (which has been already described), 5 patients developed the signs of a transitory mild subcutaneous emphysema in the neck area, 6 patients had minor left-sided pleural effusions, 4 patients had pulmonary atelectases, and 2 patients reported transitory retrostemal pains. There were no fatal outcomes.

Twenty-three (17.4%) patients had a transitory dysphagia in the first postoperative month, which persisted in the next three months in only 9 of them. There was one fatal outcome on the 6 month follow-up, and no fatal outcome on the 12 month follow-up. The "short" esophagus was registered in 2 patients with a recurrence of the disease, who were initially converted to open surgery. The Collis-Nissen fundoplication was not performed in these cases. The recurrence rate was 18.2% (24 patients) noted at the 12 month follow-up. 16 patients had a resurgery (11 laparoscopically and 5 open).

Postoperative satisfaction

The total Patients' postoperative satisfaction with any HH surgery type was evaluated 6 and 12 months after the surgery, using the Visick scale, as shown in Table 2 as well. No symptoms (Visick 1) were noted by 83 and 102 patients after the 6 months and after the 12 months, respectively. Reoperation required (Visick 4) were noted by 10 and 6 patients after the 6 months and after the 12 months, respectively.

Table 2

Patients' postoperative satisfaction with hiatal hernia (HH) surgery (Visick scale)*

Visick scale (grades)	After six months	After a year
I – no symptoms	83 (61.9%)	102 (77.3%)
II – mild symptoms	26 (19.4%)	15 (11.4%)
dysphagia	19/26	11/15
distention	8/26	5/15
epigastric pain	5/26	5/15
III – medicamentous treatment	15 (11.2%)	9 (6.8%)
dysphagia	11/15	7/9
heartburn	7/15	5/9
belching	5/15	4/9
IV– reoperation required	10 (7.5%)	6 (4.5%)
Total	134	132

***Data are given as number (percentage) of patients meeting appropriate Visick grade.**

Discussion

In a few recent decades, laparoscopic antireflux surgery has become a golden standard for GERD treatment. Numerous studies report its high efficacy (over 90%) with exceptionally good functional results and improvement of patients' quality of life [7–13]. Many studies have also confirmed that the laparoscopic treatment of large HH is safe and easily performed [6, 13, 14]. This minimally invasive procedure enables much better visualization of the hiatal region than laparotomy facilitated by a pneumoperitoneum [6].

The laparoscopic approach also enables the adequate crural repair in HH, with good results tested by numerous studies in various periods. Some studies reported the relapse rate of primary laparoscopic procedures of 2%–7% in smaller HH, while in large paraesophageal HH (≥ 5 cm diameter between the crura), the relapse rate may approach to even 45% [14–17]. This high relapse rate aroused a great debate regarding the laparoscopic repair of HH. Due to this unacceptably high relapse rate, some technical detailes were proposed (the necessity of antireflux procedure, gastropexy, hiatal repair using a prosthesis, etc.), inducing a constant professional debate [18–20]. Due to a high relapse rate of larger HH with direct suturing of the hiatal defect, it was recommended to apply a prosthesis, especially in cases with an excessively large hiatal defects in order to reduce tension at the crural suture site and produce stronger scar tissue by an incorporated mesh [18, 21]. Following the first insertion of a mesh for a hiatal closure reported in 1993, numerous techniques of prosthesis insertion were applied with the aim to reduce the relapse rate [22]. The selective application applied to the patients in whom a sufficient closure of the hiatal defect could not be achieved, with the hiatal defect site as the major criterion [18, 23, 24]. In our patients, we applied a dual, two-component Proceed® mesh, thin and flexible, with polypropylene on one side fitting on the diaphragm, and oxidized regenerated cellulose on the other, providing the bio-resorbable layer towards the viscera. The application of prosthetic materials could induce unpleasant postoperative complications, such as esophageal strictures, mesh migrations, and visceral erosions. To prevent prosthetic migrations, crural approximation was recommended whenever possible, followed by an onlay mesh installation to reinforce the hiatal defect and prevent intrathoracic fundoplication migrations [21, 23].

Most HH relapses and the resulting symptoms usually occurred on the repaired crura, no matter whether it is a stenosis of the hiatal aperture and the resulting obstruction at the gastroesophageal connection site, or migration of the fundoplication cuff into the thoracic cavity through the hiatal aperture [7, 23]. In some studies authors measured the diameter of hiatal crura and its relationship to the relapse of the disease. They found a smaller relapse rate (0.9%) when the diameter was < 4.5 cm, and the relapse rate of 11% when the diameter was > 5 cm ($p < 0.001$), making a statistical significance [25]. The initial diameter in the antero-posterior aspect could therefore be regarded as a selective indication for a mesh reinforcement of the crura.

The crucial moment contributing to a dramatic change in the adoption of anti-reflux surgery was the short, free, excessively mobilized Nissen fundoplication which dramatically reduced the postoperative complications of antireflux surgery and improved the control of the gastric content reflux into the esophagus [4, 7]. In a few recent years (2010–2014), we applied this fundoplication type in all patients with normal esophageal motility, even when the esophageal manometric findings were at the limit of the normal values. The procedure was more demanding as a more excessive mobilization of the fundus was needed, with obligatory cutting of short gastric vessels. Postoperative results of these fundoplications were much better than the standard Nissen ones with a minor mobilization of the fundus and no cutting of short gastric vessels.

Despite the good surgical results, some patients sometimes redeveloped the symptoms of gastroesophageal reflux with regurgitation, or even dysphagia, predominantly transitory in character [26, 27]. A problem appeared when dysphagia persisted over a longer period of time, which obligatory requires additional diagnostic studies. Numerous studies were carried out to select the adequate surgical procedure and principles in order to avoid failures and complications, such as dysphagia and a relapse of the disease. The "tailored approach" was mostly used to select the type of fundoplication, based on esophageal motility [7]. According to this approach, the patients with normal esophageal motility findings were

selected for the Nissen 360º-fundoplication, unlike the patients with motility disorders who were predominantly submitted to the Toupet 220º procedure [7]. This concept was based on reducing the undesirable postoperative side effects. Due to the severity of dysphagia and bloating, the Toupet fundoplication was routinely performed by some authors, regardless the esophageal manometry findings [1, 28]. The effects of these treatments were reviewed in prospective studies which evaluated the results of a five-year surgical practice in 100 patients submitted to laparoscopic Toupet fundoplication regardless esophageal manometry findings [1]. On the basis of this study results and the analysis of the previously obtained results and the patients' satisfaction, a relatively low relapse and morbidity rates were recorded. When the safety and efficacy of the procedure were already confirmed, it was recommended as the method of choice for the primary surgical treatment of patients with GERD and minor HH [1]. Nevertheless, many authors consider dysphagia is morphologically primarily due to ineffective hiatal closure, rather than to an inadequate fundoplication [7, 27]. Analyzing the major causes of postoperative dysphagia, one study reported that the morphologic-anatomic causes of dysphagia might be attributed to the difficulties with hiatal closing in 90% of the cases and in only 10% to an inadequate fundoplication (too long or too tight), or the intrathoracic fundoplication migration was involved, possibly resulting in a partial or total disruption and obstruction [7]. The cases of recurrent or persistent dysphagia due to the so-called "slipped Nissen", induced by a partial or total disruption of the primary posterior hiatal repair were also reported [7, 28]. In addition, postoperative dysphagia may largely be due to an excessively tight hiatal repair, i.e. to an artificially created hiatal stenosis because of a great number of sutures. To avoid this, many authors recommended calibrated probes for esophageal hernias. The prosthetic material for crural reinforcement can also produce postoperative dysphagia, which may induce adhesions, particularly as the result of the scar tissue developing at the crura.

Another important component is recognition of the so-called short esophagus, considered to be the major cause of the relapse. In these cases some authors recommend the "wedge-Collis" gastric repair which produces less tension on the hiatal repair and reduces a relapse of the disease [29]. In our study we did not note so-called short esophagus, nor performed "wedge-Collis" gastric repair.

The operative approach was individualized. Depending on the type of a surgery performed at our clinic, the patients were subclassified in three historical phases according to the type of fundoplication performed after the hiatal repair. The posterior hiatal repair was carried out in all patients, applying interrupted Ethibond® 00 sutures.

At the beginning, in the first historical phase (2004–2005), when we introduced laparoscopic procedures, we initially performed the Door fundoplication (5 patients). Soon afterwards, in the second historical phase (2005–2010), we started to perform the standard Nissen fundoplication. In the next 3–4-year period, we performed it in 33 (25%) patients and the Toupet fundoplication in 8 patients. Due to dysphagia and postprandial bloating as common postoperative complications of the Nissen fundoplication, the Toupet fundoplication was introduced and routinely performed in the next 44 (33.3%) patients, while the standard Nissen fundoplication was performed in 9 patients in the following period. In the third historical phase (2010–2014), the "short-floppy" Nissen fundoplication was predominantly performed – in 26 (19.7%) patients. It was usually performed in the patients without serious motility disorders registered on esophageal manometric series. However, the Toupet procedure was performed in only 7 patients with abnormal esophageal motility. In the analyzed period, the total of 68 (51.5%) Nissen, 59 (44.7%) Toupet, and 5 (3.8%) Door fundoplications were performed.

Limitation of this study are its retrospective nature and only one group of the patients suitable for analysis because we reviewed only historical phases. This can be improved by new prospective studies on at least two groups of patients.

Conclusion

Based on our experience, laparoscopic surgery of the HH with the hiatal repair and fundoplication is considered a safe and effective treatment modality. Posterior hiatal repair with a mesh is recommended in selected cases (in large HH ≥ 5cm in diameter, and in recurrent HH). Whenever inserting the prosthetic material, two-component meshes should be applied to reduce the mesh-related complications. We tried to formulate an acceptable solution to perform the HH surgery in a safe and effective way. We proposed a well mobilized "short floppy" Nissen fundoplication if no significant pressure reduction was registered by the preoperative manometric studies. Acceptable solution is and Toupet fundoplication in selected cases.

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