MINIMALLY INVASIVE ANTIREFLUX SURGERY: HIGH VOLUME CENTER EXPERIENCE OF FIRST 550 CASES

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Abstract

Introduction: This work is a presentation of a ten-year experience of minimally invasive antireflux surgery by a surgical team in a highly specialized center.

Materials and Methods: An observational retrospective clinical study with prospective follow-up was conducted, including consecutively operated patients who underwent minimally invasive surgery for gastroesophageal reflux disease (GERD) and giant hiatus hernia (GHH). The research was carried out at the Esophageal Surgery Center, Digestive Surgery Clinic, University Clinical Center of Serbia, from January 2010 to January 2020. Comprehensive preoperative and intraoperative findings, surgical procedures, and postoperative monitoring details are presented.

Results: In total, 550 consecutive patients were included in the study. Minimally invasive antireflux surgery was performed in 260 patients for GERD, while surgery for giant hiatus hernia (GHH) and its subgroup involving intrathoracic gastric positioning was conducted in 184 and 106 patients, respectively. There were no conversions to open procedures. Pneumothorax occurred in 21 patients as a result of intraoperative pleural injury. Two patients required re-intervention due to port-site bleeding. Short-term and long-term follow-up outcomes are highly satisfactory and have been presented in detail.

Conclusion: The introduction and implementation of minimally invasive antireflux surgery, when properly executed within a highly specialized center, can lead to a low incidence of complications and highly satisfactory short-term and long-term functional outcomes.

Keywords: minimally invasive surgery, antireflux surgery, gastroesophageal reflux disease, giant hiatus hernia

Introduction

Within human nature exists a drive for progress and constant evolution, always striving for perfection. At the end of the previous century, significant changes occurred in the realm of surgery. These changes weren't a result of newfound knowledge about surgical ailments or new medications, but rather stemmed from the introduction of Minimally Invasive Surgery (MIS) and the fundamental principles of non-invasive yet simultaneously effective and intricate surgical work. All of this can be aptly described through the quote, "Accomplish more, by doing less", a principle introduced by Albert Einstein.

The advantages of MIS are reflected in quicker patient recovery, reduced frequency of postoperative pain, and standardization of surgical procedures. Numerous studies have been conducted, demonstrating equal or even superior outcomes in terms of short-term and long-term postoperative complications, recovery time, pain management, and hospital stay. Today, MIS stands as the gold standard against which upcoming new surgical techniques will be compared in the future[1].

Considering the benign foregut pathology, the minimally invasive approach found its place rather early, with huge development over the years. Surgical treatment of GERD and hiatal hernias became more feasible and widely accepted due to the introduction of laparoscopy, with favorable results over the open technique[2, 3]. We can say that MIS in benign foregut pathology is now a standard approach, with well-proven, highly satisfactory results[4, 5].

This study aims to present the experience of a surgical team at a highly specialized department for upper gastrointestinal surgery, with a focus on the initiation and ten-year implementation of minimally invasive antireflux procedures.

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The study encompasses the experience of the initial 550 consecutive cases, highlighting preoperative diagnostics, intraoperative techniques, data related to intraoperative complications, and long-term outcomes, with an emphasis on symptomatic outcomes and anatomical recurrences.

Material and Methods

This observational study was conducted at the Esophageal Surgery Center, Digestive Surgery Clinic, University Clinical Center of Serbia. The study included surgically treated patients with Gastroesophageal Reflux Disease (GERD) and Hiatal Hernia (HH) from January 2010 to January 2020. Collected data encompassed preoperative and intraoperative findings, as well as information about prospective postoperative follow-up.

The preoperative evaluation of patients with GERD included: a symptom questionnaire, upper gastrointestinal endoscopy, esophageal stationary manometry, and barium contrast radiography of the esophagogastroduodenal region. In the absence of reflux esophagitis, a 24-hour pH monitoring/impedance of the esophagus was conducted. For patients with Giant Hiatal Hernia (GHH) and intrathoracically positioned stomach (Upside down stomach), the preoperative evaluation involved: a symptom questionnaire, upper gastrointestinal endoscopy, barium contrast radiography of the esophagogastroduodenal region, and computed tomography of the chest and abdomen.

Data regarding the surgical procedure encompassed the duration of the procedure, intraoperative complications, the type of fundoplication, and the type of diaphragmatic hernia repair.

Postoperative follow-up consisted of regular check-ups at 3 and 6 months after the operation, followed by annual visits. The first routine upper gastrointestinal endoscopy was conducted one year post-operation, and subsequently every 3 years. In case of symptom occurrence, an upper gastrointestinal endoscopy was performed regardless of the scheduled follow-up visits.

Diagnostic Studies

Barium contrast radiography of the esophagogastroduodenal region was performed in frontal and two lateral planes. The specific test for detecting gastroesophageal reflux was conducted using the "Barel roll" maneuver. Preoperative upper gastrointestinal endoscopy was mandatory for all patients and was carried out by our surgical team. Reflux esophagitis was classified according to the "Los Angeles/LA/Classification". In cases where reflux esophagitis was present, proton pump inhibitors were administered until complete healing was achieved before surgery. Barrett's esophagus (BE) was classified according to the "C and M"

Prague Criteria and histologically confirmed as cylindrical epithelium containing goblet cells.

Esophageal stationary manometry was conducted in patients with GERD to obtain data on esophageal motility, length, and basal pressure of the lower esophageal sphincter. For patients with Non-Erosive Reflux Disease (NERD), a 24-hour pH monitoring/impedance of the esophagus was performed to assess the type and extent of reflux, establishing a correlation between symptoms and reflux episodes.

Surgical procedures

Operating room set-up and port positioning

The patient is positioned in the supine position, in reverse Trendelenburg position, with legs spread apart, hips at the edge of the table, and both arms extended. The surgeon stands between the patient's legs, and the first assistant is positioned on the patient's left side. The port placement has always been consistent, with one camera port positioned at the midpoint between the xiphoid process and the umbilicus, 2 cm to the left of the midline. Two working ports for the surgeon are placed, one below the left subcostal area (12 mm) and the other on the right (5 mm). A Nathanson liver retractor is placed beneath the xiphoid process. A 5 mm port for the first assistant is positioned in the left anterior axillary line.

Specifics of surgical procedures

a. Surgical technique for GERD

The procedure starts with the opening of the gastrohepatic ligament, with routine sparing of the hepatic branch of the vagal nerve. After careful visualization of the right crus, we start dissection of the hiatus, from the right, with preservation of the crural peritoneal covering. After the anterior plane of the esophagus is dissected, we approach the left crus. The "Angle of His" must be deliberated completely. Type II mediastinal dissection of the esophagus is performed to get a sufficient length of the intraabdominal esophagus. After full exposure of both crura, dissection of the posterior aspect of the esophagus is done, followed by the encirclement of the esophagus with the soft rolled gaze. Fundus of the stomach is fully mobilized by cutting short gastric vessels and posterior attachments of the proximal corpus and fundus. The first 2–0 non-absorbable suture is placed just above the crural junction for hiatal closure, with additional interrupted stitches placed 1 cm apart. We usually use the "figure of eight" type of suture. Sufficient space of 10 mm must be kept between the esophagus and the last crural stitch, taking care to avoid the traction of the esophagus when calibrating hiatal opening.

We create the fundoplication by grasping the posterior fundus and passing it behind the esophagus from left

to right. The "Shoeshine maneuver" is always performed to estimate the tension-free fundoplication and to avoid twisting the posterior fundoplication wall. The wrap measures no more than 2–2.5 cm in length and is always placed above the Belsey's fat pad. Two types of fundoplication for GERD patients have been employed: Nissen and Brandalise. In Nissen's fundoplication suturing is achieved by using three single 2-0 monofilament interrupted stitches, which the first includes a bite of the esophageal muscle. Occasionally, one additional suture was placed between the right and/or left side of the wrap and the upper crura. In Brandalise's fundoplication we combined two 2-0 monofilament interrupted stitches between the fundus of the stomach and the body of the esophagus on both sides of the fundoplication, with the "U" stitch positioned between them.

b. Surgical technique for GHH and "Upside down stomach"

After exposing hiatus, herniated stomach is reduced into the abdomen using atraumatic graspers in a "hand-over-hand" fashion. Dissection is started by dividing the gastrohepatic ligament and exposing the right crus of the diaphragm using ultrasonic shears. The hernia sac and the gastroesophageal fat pad are carefully dissected out, sweeping the anterior vagal nerve to the right of the esophagus with the fat pad. A combination of sharp dissection with ultrasonic shears and blunt dissection with graspers is used to completely remove the hernia sac from the mediastinum. The distal esophagus is then mobilized as superiorly as possible (type II mediastinal dissection) to determine whether esophageal shortening is present. Sometimes if hiatus is extremely enlarged and the approach to the right crus proves difficult and dangerous due to the risk of injuring the inferior vena cava, we used the so-called "left-side approach". In this approach, the dissection begins with the identification of the left crus of the diaphragm and the division of the peritoneum and the pharyngoesophageal membrane overlying it. With this technique, the vena cava is never at risk, and the branches of the anterior vagus nerve and the left gastric artery are less exposed to danger.

The crural repair was conducted as a standard posterior cruroraphy or, especially in the intrathoracic stomach, as a bidirectional complex repair. If there was an enlargement of the left crus, a complex bidirectional diaphragmatic repair with separate left lateral and posterior crural suture lines was performed in the manner described by Rice et al[6]. Stitches are initially placed on the left crus, optimizing it to a normal length, after which posterior cruroraphy is performed between crural pillars of equal size. After performing the adequate geometry of the fundoplication around the distal esophagus, Toupet's fundoplication is performed using four single 2-0 monofilament interrupted stitches on both sides of the fundoplication, with two most proximal stitches from both sides engaging the crura.

Postoperative care and monitoring

A nasogastric tube is routinely placed and usually removed on the same evening, with patients commonly being hospitalized for 48 hours. Adequate postoperative pain management is achieved through the administration of intravenous analgesics, while intravenous antiemetic medications are given according to the Postoperative Nausea And Vomiting (PONV) protocol (dexamethasone, ondansetron, and metoclopramide) to prevent vomiting that could impact the performed hiatal hernia repair and fundoplication in the early postoperative phase. Barium contrast radiography of the esophagogastroduodenal region is routinely conducted on the morning after the operation. The examination is always performed in both frontal and lateral views to better assess the position and function of the fundoplication, possible herniation or disruption, and to detect signs of leakage.

On the first postoperative day, liquid nutrition is initiated, followed by a semi-solid diet the next day. Patients are discharged home on the second postoperative day and are on a semi-solid diet for the next 2-4 weeks. Patients have regular outpatient check-ups after 4 weeks, followed by visits at 3 and 6 months, and subsequently annually.

Results

In total, 550 consecutive patients were evaluated in this clinical study. The results of three separate patient subgroups will be presented individually - GERD, GHH, and intrathoracically positioned stomach.

a. GERD

During the observed period, 260 patients (47.2%) underwent surgery for GERD, with the majority being males (79%). The average age in this group was 47 years, ranging from 23 to 67 years. The main indications for surgery included inadequate medical treatment due to anatomical variations, unsuccessful treatment, complicated GERD, and extragastric manifestations. Preoperative evaluation in this patient group revealed the presence of type I axial hiatal hernia (HH), of which 168 (64.6%) had HH greater than 3 cm in length.

Reflux esophagitis was present in 210 patients (80.8%), with LA grade A present in 94 (45%), LA grade B and C in 52 (25%) and 30 (14%) patients, respectively. Endoscopic LA grade D was found in 34 patients (16%) who had varying degrees of peptic stricture. Among them, 21 required preoperative endoscopic balloon dilation. After histopathological examination, BE was confirmed in 64 patients, with an average length of C segment of 2.1 cm and M segment of 3.7 cm according to the Prague classification. Among the 38 patients with BE (long-segment intestinal metaplasia and low-grade dysplasia), preoperative, intraoperative, and

postoperative endoscopic "Barrx Radiofrequency Ablation" was performed.

The most common functional disorder in the GERD patient group was a defective Lower Esophageal Sphincter (LES), defined as a resting pressure < 6 mm and a total length of LES < 2 cm. These criteria were found in 88.9% of patients. The average preoperative resting LES pressure was 4.9 ± 3.1 mmHg, and the average total LES length was 1.3 ± 0.8 cm. Inadequate esophageal body motility was present in 121 patients (46.9%).

In all 50 patients without the presence of reflux esophagitis on endoscopy, preoperative 24-hour pH monitoring/impedance of the esophagus was performed. The average value of the composite DeMeester score in these patients was 36.3 ± 17.1.

In all patients with GERD, Nissen fundoplication was performed with an average operation duration of 62 ± 17 minutes. There were no conversions to open surgery or reoperations in this patient group. Six patients experienced intraoperative pleural injury, which was immediately managed during surgery, while the other two had a wound infection at the 12 mm port.

The median follow-up for this patient group was 23 ± 8.2 months. During this period, a favorable symptomatic outcome was achieved in 239 (92%) patients, with a reduction in the mean DeMeester symptom score from 7.1 preoperatively to 2.2 postoperatively. Postoperative dysphagia was present in 128 (49%) patients, with a median duration of 46 days (7-81 days).

b. GHH

Due to the presence of Giant Hiatal Hernia (20 to 70% upside-down stomach that was detected by barium contrast radiography of the esophagogastroduodenal region), a minimally invasive antireflux procedure was performed in 184 (33.5%) patients. The average age in this subgroup was 60 years (ranging from 35 to 73), with a majority of female patients (67.6%). All patients underwent laparoscopic surgery, involving steps such as esophageal and hiatal dissection, excision of the hernia sac, hiatal repair, and either Tupet's or Brandalise's fundoplication. The average duration of the operation was 142 ± 27.1 minutes. Bidirectional closure of the hiatal space was performed in 126 (68.4%) patients. In six patients, intraoperative pleural injuries occurred. The median follow-up in this patient subgroup was 19 ± 8.7 months. Recurrences of hiatal hernia, mainly asymptomatic, were observed in 19 patients (10.8%) during regular endoscopic examinations conducted one year after the operation.

c. Intrathoracic stomach

Our team performed the first laparoscopic surgery of an intrathoracically positioned stomach in our country and region in January 2010. In ten years, 106 patients (19.3%) were operated on due to complete intrathoracic position of the stomach or type IV of hiatal herniation "Upside-down stomach". The majority of these patients expressed regurgitation as the dominant symptom, while reflux symptoms were observed in only 25% of patients. Chest pain was present in 29.7%, dyspepsia in 36%, and 21.6% of patients suffered from frequent vomiting. In this group of patients, preoperative chest and abdomen CT scans were performed in 58 patients (55%), revealing the presence of colon herniation in 24. In all patients, the surgical procedure consisted of bidirectional hiatal opening and Toupet's fundoplication. Pleural lesions happened in 9 patients. Median follow-up in this subgroup of patients was 24 ± 4.7 months. HH recurrence was observed in 9 patients (8%) on regular endoscopic checkups which were conducted 1 year after surgery.

Discussion

The contemporary approach in benign upper gastrointestinal surgery is predominantly oriented towards the use of laparoscopy, thoracoscopy, and robotics, making minimally invasive surgery (MIS) the standard in treating benign esophageal disorders. Laparoscopy offers several well-known advantages, both from an economic perspective and in terms of patient well-being[7]. Reduced postoperative complications and postoperative pain, as well as shorter hospital stays, are advantages of MIS, which decrease the severe complications that could potentially arise after traditional surgery.

The study primarily addressed the two most common indications for laparoscopic surgery of the foregut: GERD and GHH. In patients operated on due to GERD, we had no reoperations and no conversions to open procedure. We have not provided our results with previous open surgery, but operative time was highly comparable and did not exceed 1 h in 87% of the performed procedures. Most patients left the hospital on the second postoperative day.

Our study was focused on the two most common indications for laparoscopic benign upper gastrointestinal surgery: GERD and GHH. These procedures accounted for over 90% of all interventions performed during the observed period. The group of patients who underwent laparoscopic procedures for GERD showed excellent results, with no need for conversion and no reoperations. When considering the duration of the procedure, the surgical time did not exceed 1 hour in 87% of cases. The majority of patients were discharged on the second postoperative day, significantly reducing hospital stays. A lower incidence of recurrent HH and incisional hernias are outcomes that favor the laparoscopic approach for these patients compared to conventional surgery. In a randomized controlled trial with a 15-year follow-up period comparing open and laparoscopic Nissen fundoplication, functional and subjective patient outcomes were found to be comparable[8].

On the other hand, among patients who underwent surgery using the conventional approach, a higher incidence of recurrent HH and incisional hernias was recorded, which highlights laparoscopy as a more effective method of choice in GERD treatment[9]. Furthermore, when assessing the effectiveness of surgical procedures for GERD, it must be kept in mind that with the emergence of MIS, antireflux surgery has become widely conducted by general surgeons. This fact partially explains the less favorable long-term outcomes of laparoscopic antireflux surgery, as these procedures have become part of surgical practice not only in highly specialized upper gastrointestinal surgery centers but also in other less specialized medical facilities. This may be the reason why some gastroenterologists emphasize the poor long-term results of gastroesophageal reflux control achieved through laparoscopic antireflux surgery, as demonstrated in certain large epidemiological studies involving patients operated on in both specialized and less specialized hospitals. However, looking at studies from experienced surgical centers, it is a common practice to achieve excellent long-term outcomes. In most cases, it is not solely about surgical technique but also about appropriate indications for antireflux procedures[10].

Laparoscopic Nissen fundoplication (LNF) is a standard procedure in our department for patients coming in for surgical treatment of GERD. We have demonstrated in some of our earlier research that the frequently observed inadequate esophageal motility in these patients does not rule out NF and that the majority of these patients will recover their esophageal function following surgery[11]. Several other investigations also showed that NF improved esophageal motility. In the group of patients who underwent GERD surgery in our study, the median time for dysphagia following LNF was 26 days, and it always resolved on its own[12, 13]. Most likely, the floppy alteration of NF, which offers effective and long-term antireflux control with a minimum of negative side effects, is the cause of this short-term dysphagia. The introduction of the Brandalise technique in our department was induced by the desire to preserve excellent antireflux control, and to minimize side effects of NF, predominantly to diminish dysphagia and bloating syndrome rates.

We have also demonstrated that laparoscopic surgery is possible and can be carried out with the same success as conventional surgery, if not better[14-16] in the case of enormous paraesophageal HH. And in this group of patients was no conversions to open surgery, reoperations, or significant intraoperative problems. Pleural lesions were noticed in a few patients, but no other unfavorable consequences occurred. Given that these patients have a high risk of developing postoperative incisional hernias, the absence of a large incision was likely the major benefit for these individuals[17]. In the subgroup of patients with paraesophageal HH, we often utilize a unique crural closure technique first described by Rice and colleagues. This bidirectional method of crural closure, in short-term follow-up, presents a potential strategy for preventing hernia recurrence, as it avoids the serious complications that mesh placement might entail[18]. Complete excision of the hernia sac is of particular significance, as it can improve subsequent crural closure and facilitate fundoplication – two factors that could play a pivotal role in hernia recurrence prevention. Another important topic is the so-called "short esophagus" and the need for esophageal lengthening procedures according to Collis. Our opinion, based on extensive experience, is that the "short esophagus" is typically only observed in patients with severe peptic esophageal strictures. Such patients are often candidates for esophageal resection rather than elongation. Conversely, encountering an issue with intraabdominal esophageal length in patients with axial HH or GHH, in the absence of peptic strictures, is less likely. Hence, we emphasize the significance of adequate mediastinal dissection, a method that has proven highly effective in achieving proper esophageal length.

Conclusion

Our study confirms that the introduction and long-term implementation of minimally invasive surgery in specialized surgical centers for the treatment of benign foregut disorders can be obtained with a low incidence of complications and satisfactory short and midterm structural and functional results. It is our strong position that only specialized centers should deal with minimally invasive antireflux surgical procedures, as they ensure the high frequency of patients, the possibility of adequate diagnostic protocols, a high level of expertise and as a result, optimal method of treatment.

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