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Minimally invasive surgical methods in patients with gastroesophageal reflux disease and hiatal hernia

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Abstract. *The therapeutic results among 281 patients with GERD, who were admitted during 2015-2021 to the clinic of surgery and endoscopy of the Faculty of postgraduate education of the Danylo Halytsky Lviv National Medical University, were analyzed. They were divided into 3 groups: Group I - laparoscopic antireflux surgery using our own modification (patent of Ukraine № 59772), included 62 patients; Group II (195 patients) – laparoscopic Nissen fundoplication; Group III (24 patients) – laparoscopic Toupet fundoplication. In two cases were performed robot-assisted da Vinci operations. 36 months after surgery - the difference in the number of recurrences of GERD - 1.6 % vs. 7.7 %, recurrences of hiatal hernia 1.6 % vs. 3.3 % between groups I and II, the number of recurrences of GERD between groups I and III 1.6 % vs. 12.5 %, recurrences of hiatal hernia 3.2 % vs. 8.3 %.*

The application of a new integrated approach to the surgical treatment of GERD and HH reduces the number of postoperative complications such as gas-bloat syndrome by 3, dysphagia by 5 times, the number of recurrences of GERD and hiatal hernia by 5 and 2 times, improves the quality of life of patients by 2.6 times after 36 months after surgery and increases the timeliness of diagnosis and the choice of differentiated treatment tactics.

Key words: *minimally invasive surgical methods, gastroesophageal reflux disease, hiatal hernia*

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I. Introduction

Gastroesophageal reflux disease (GERD) is a condition that occurs with reflux of gastric contents and causes certain "disturbing" symptoms and/or complications. Symptoms are considered "disturbing" if they adversely affect a person's well-being [4]. The causes of GERD include: decrease in the function of the antireflux barrier (primary decrease of pressure in the lower esophageal sphincter, increase in the number of episodes of its relaxation, complete or partial destructuring due to hiatal hernia (HH), short esophagus); decrease in esophageal clearance (chemical – due to reduction of the neutralizing effect of bicarbonate of saliva and esophageal mucus, volumetric – due to suppression of peristalsis and decrease in the tone of the thoracic esophageal wall, damaging effect of refluxate, the inability of the mucous membrane of the esophagus to counteract the damaging agent, violation of gastric emptying due to pylorospasm or ulcerative stenosis of the stomach, increased intra-abdominal pressure due to pregnancy or overweight, direct damaging effect of drugs against the esophageal mucosa, decreased pressure in the lower esophageal sphincter due to side effects of drugs) [3, 5, 10].

Protective properties of the mucous membrane of the esophagus have pre-epithelial, epithelial and post-epithelial levels. The pre-epithelial level includes the water layer, the mucus layer and the presence of an increased concentration of bicarbonate ions. The epithelial level includes the structural and functional features of cellular structures: membranes, intercellular connections, intracellular and intercellular transport, which creates the optimal pH (7.3-7.4), as well as the peculiarities of epithelial cell reproduction. The postpithelial level of protection is determined by adequate blood supply and maintenance of tissue pH. Since the aggressive factor acts mainly in the esophageal lumen, the main protection of the mucous membrane is the mechanism of pre-epithelial protection. Normally, this protective component is enhanced by the quantity and quality of the organic components of saliva (mucin, mucin-free protein, epidermal growth factor and salivary prostaglandin E2). In patients with reflux esophagitis, a significant slowdown in the secretion of mucin and mucin-free protein in response to intraesophageal mechanical and chemical irritation was found [8, 9, 10].

Surgical treatment of GERD should be aimed at restoring the anatomical structures of the antireflux barrier and prevention of recurrence. Antireflux operations are indicated for complicated GERD (recurrent bleeding, peptic strictures of the esophagus, Barrett's esophagus), as well as in case of ineffectiveness of drug therapy, especially in young patients who require maintenance therapy in high doses. Indication for surgery - GERD, combined with a hiatal hernia [2, 7].

A large number of publications are devoted to the problem of surgical treatment of GERD [1, 2, 4, 6], but postoperative complications remain quite high: failure of the esophageal-gastric junction is 55-60% of the

total number of complications, and mortality from esophageal-gastric bleeding is 5-15%. GERD is often combined with large and giant HH (50-90%) and poses a high risk of complications such as gastroesophageal ulcers and bleeding, metaplasia and adenocarcinoma of the esophagus, strictures, perforations, compression of the mediastinal organs. The level of satisfaction from surgical treatment in patients with GERD is 62-97%, and in the long run (after 5 years) this figure is 80-96%. Quality of life significantly improves after antireflux laparoscopic surgery based on the results of both short- and long-term studies, including general and specific follow-ups. Specific intraoperative complications include perforation of the stomach and esophagus, pneumothorax, vagal injury. The highest incidence of perforation (1-4%) is observed in refundoplication. The authors who studied the methods of antireflux laparoscopic surgery, in particular thoracoscopic ones, report higher levels of perforation of the stomach and esophagus (6.7-9.1%). Purulent-septic complications include wound infections (ranging within 0.2-3.1%) and postoperative hernias (ranging within 5-9%). High incidence (within 2-25%) of esophageal complications (prolonged dysphagia, strictures, esophageal erosion) after some types of alloplasty requires careful study of the choice of hiatal plastic's type and methods of its performance [4, 6].

During recent years, the types of laparoscopic surgery for GERD have undergone significant modifications, but the number of complications remains high. Among them the most important is the GERD recurrence, HH, sliding of the fundoplication cuff, dysphagia, gas-bloat syndrome. The wrong choice of operation's type, the occurrence of postoperative complications and, as a consequence, the deterioration of quality of life make this pathology one of the relevant problems in modern surgery [1]. The main unsolved problems that affect the occurrence of complications are: indications for surgical treatment of patients with GERD, combined with HH, preoperative preparation and diagnostic methods, determining the prognosis of recurrence (determining the size of hernia, obesity, increased intra-abdominal pressure), technical aspects of surgery (choice of access, excision of the hernia sac, type of hernioplasty and fundoplication), prevention of intra- and postoperative complications.

Thus, despite the reasonable expediency of using minimally invasive methods for the diagnosis and treatment of GERD, the issues of reducing the number of recurrences, complications after surgery and improving the quality of life of these patients remain open.

The purpose of our work is to analyze the effectiveness of various methods of minimally invasive antireflux surgery in patients with gastroesophageal reflux disease and hiatal hernia.

II. Materials And Methods

The therapeutic results among 281 patients with GERD, who were admitted during 2015-2021 to the clinic of surgery and endoscopy of the Faculty of postgraduate education of the Danylo Halytsky Lviv National Medical University, were analyzed. They were divided into 3 groups: Group I - laparoscopic antireflux surgery using our own modification (patent of Ukraine № 59772), included 62 patients; Group II (195 patients) – laparoscopic Nissen fundoplication; Group III (24 patients) – laparoscopic Toupet fundoplication. In two cases were performed robot-assisted da Vinci operations.

The mean age of patients was 53.4 ± 11.7 (18-74) years. The mean body mass index (BMI) was 29.1 ± 1.2 (19.1-40.2) kg/m^2.

The distribution according to the grade of reflux esophagitis (LA classification) was as follows: grade A – 105 patients (37.4%), grade B – 134 patients (47.7%), grade C – 40 patients (14.2%), grade D – 2 patients (0.7%).

The average hiatal area (HA) was 6.5 ± 1.8 (3.9-10.1) cm^2. The average period of long-term results' evaluation is 27.1 ± 11.7 (12-36) months.

On December 9, 2020, the first time in Ukraine Nissen fundoplication using da Vinci surgical system was performed by Andrii Stasyshyn - Professor Department of Surgery and Endoscopy, Faculty of post-graduate medical training Danylo Halytsky Lviv National Medical University, Ukraine.

Computer program Statistica 10.0 (StatSoft) was used to perform statistical data analysis. The latter was based on three types of research: 1) descriptive statistics, 2) testing the normality of the distribution, 3) testing the statistical significance of differences. The level of significance for statistical tests was chosen as 5%, i.e. the null hypothesis was rejected, if $p<0,05$.

III. Results

In group I – the average score of the visual analog scale (VAS) for reflux symptoms was 0.6 ± 0.2 (0-6) points, for dysphagia – 0.2 ± 0.1 (0-6) points, for extraesophageal symptoms – 0.2 ± 0.1 (0-1) points. The average quality of life score according to the GERD-HRQL questionnaire was 1.1 ± 0.4 (0-10) points. The distribution by satisfaction's level was as follows: completely satisfied – 59 patients (95.2%), partially satisfied – 1 patient (1.6%), dissatisfied – 2 patients (3.2%). The distribution by grade of reflux esophagitis according to LA classification was as follows: 0 degree was observed in 60 patients (96.8%), grade A – in 2 patients (3.2%),

grade B, C and D – in 0 patients (0%). The average DeMeester score was 7.0 ± 2.8 (1.1-45.2). The average radiological oesophageal transit time (ROTT) was 3.3 ± 0.9 (3-7) s. The hemoglobin level was 124.6 ± 7.2 (110-149.8). The mean BMI was 29.6 ± 4.5 (20-39.8).

In group II - the average VAS score for reflux symptoms was 2.1 ± 0.8 (0-6) points, for dysphagia – 1.2 ± 0.4 (0-6) points, for extraesophageal symptoms – 0.5 ± 0.2 (0-4) points. The average quality of life score according to the GERD-HRQL questionnaire was 2.9 ± 1.1 (0-9) points. The distribution by satisfaction was as follows: satisfied – in 78.0%, partially satisfied – 16.5%, dissatisfied – 5.5%. The average DeMeester score was 15.3 ± 1.8 (1.7-67.9). The average ROTT was 5.8 ± 1.9 (3-7) s. The average hemoglobin level was 119.4 ± 2.7 (108.7-137.3). The mean BMI was 28.5 ± 2.1 (20.9-37.7).

In group III - the average VAS score for reflux symptoms was 2.8 ± 1.1 (0-6) points, for dysphagia – 1.9 ± 0.4 (0-6) points, for extraesophageal symptoms – 0.8 ± 0.2 (0-5) points. The average quality of life score according to the GERD-HRQL questionnaire was 4.0 ± 1.6 (0-10) points. The distribution by satisfaction was as follows: satisfied – 17 patients (70.8%), partially satisfied – 4 patients (16.7%), dissatisfied – 3 patients (12.5%). The distribution according to the grade of reflux esophagitis (LA classification) was as follows: 0 degree was observed in 16 patients (66.7%), grade A – in 4 patients (16.7%), grade B – in 4 patients (16.7%) . The mean DeMeester score was 23.0 ± 2.4 (3.4-92.1). The average ROTT was 5.8 ± 2.3 (3-7) s. The average hemoglobin level was 112.3 ± 6.3 (128.3-149.1). The mean BMI was 25.7 ± 2.5 (22.7-39.1).

The da Vinci robot-assisted Nissen fundoplication was performed in two patients as follows: five trocars (three 8.5 mm robot-assisted and two 5 mm laparoscopic ones) were inserted into the abdominal cavity, and a 12 mm Hg carboxyperitoneum was applied. The lower segment of the esophagus was dissected and mobilized, the Lymer-Bartelli ligament was crossed with a LigaSure electrocoagulator (Covidien, USA), the hepatic branch of the n. vagus was isolated, the EH, and subsequently the right and left crura of diaphragm were identified. The esophagus together with the posterior branch of the n. vagus was fixed by the handle and exposed to traction. We mobilized the gastric fundus by crossing the short vessels of the stomach. The EH was narrowed by suturing the crura of the diaphragm with two Z-shaped sutures behind the esophagus so that the distance between the esophagus and the sutures bilaterally was 5 mm. An antireflux cuff (2 cm long) was formed by moving the bottom of the stomach behind the esophagus by 360° using three EndoStitch sutures to capture the esophagus. The distance between the diaphragm and the upper suture on the cuff was 2 cm. The patency of the esophagus was checked with a "marker" of the inflated cuff of the probe with a diameter of 2 cm. The duration of the operation was 6 hours. There were no intra- and postoperative complications. The patients was discharged home on 3rd post-op day in satisfactory condition.

IV. Discussion

Gastroesophageal reflux disease and hiatal hernia are currently one of the most common diseases of the gastrointestinal tract. GERD is recognized as a disease of the XXI century, which affects from 20 up to 50% of the population around the world. GERD and HH remain the leading causes of reduced quality of life, efficiency and the development of a number of complications. The relevance of the problem increases in case of complicated GERD and the development of extraesophageal manifestations of the disease, which complicates the diagnosis and selection of optimal treatment tactics. Difficulties in the diagnosis of GERD are explained by: atypical course of the disease, presence of comorbidities, lack of "gold standard" examinations.

During recent years, the types of operations for GERD have undergone significant modifications, but the number of postoperative complications remains high. The recurrence rate after HH plastic averages 25%, reaching 60% and can be solved through a comprehensive approach to the diagnosis of GERD combined with HH. The high incidence of postoperative complications, such as dysphagia, gas-bloat syndrome, slipping of the fundoplication cuff and that of esophageal complications (ranging within 2-25%), such as prolonged dysphagia, strictures, esophageal erosion after some types of alloplasty, require a search for ways to eliminate them, careful study of the options of the hiatal plastics' method and the development of reliable fundoplication and methods of its performance.

The main unexplored issues are indications for surgical treatment of patients with GERD, preoperative preparation and diagnostic methods, surgical treatment versus medical one, the advantages of different methods of surgery, laparoscopic surgery compared to open one, technical aspects of operations, prevention of intra- and postoperative complications.

From the performed analysis of long-term results and their comparison with baseline and inter-group data, it follows that in 36 months after surgery there is a statistically significant difference in favor of group I on the average VAS score for reflux symptoms, dysphagia and extraesophageal symptoms, the average score of quality of life according to the GERD-HRQL, mean DeMeester score, distribution of patients by their satisfaction, grade of reflux esophagitis according to the Los Angeles classification, gas-bloat syndrome.

When applying a new integrated approach to the diagnosis and treatment of GERD, which includes the usage of proposed modern diagnostic methods, developed by us method of operation based upon topographic

and anatomical features of the esophageal-gastric junction and adjacent structures, minimally invasive surgery, laparoscopic and endoscopic approaches, usage of developed diagnostic and therapeutic algorithm reduces the number of postoperative complications such as: gas-bloat syndrome – 3-fold, dysphagia – 5-fold, GERD and HH recurrences 5-fold and 2-fold, correspondingly, improves the quality of life of patients by 2.6 times in 36 months after surgery and increases the timeliness of diagnosis and the choice of differentiated treatment tactics.

The usage of minimally invasive, laparoscopic, endoscopic techniques, as well as that of da Vinci surgical system in clinical practice will improve therapeutic outcomes and quality of life among patients with surgical disorders.

V. Conclusions

1. 36 months after surgery the difference between groups I and II in the number of GERD recurrences was 1.6% vs. 7.7%, that of HH recurrences – 1.6% vs. 3.3%, the difference between groups I and III in the number of GERD recurrences was 1,6% vs. 12.5%, that of HH recurrences – 3.2% vs. 8.3%.
2. Analysis of the results of GERD surgical treatment revealed the causes (application of the operative method, technical aspects during the intervention: removal of the hernia sac, expanded mediastinal dissection; hernia size, choice of hernioplasty and fundoplication method, presence of obesity, GERD complications, intensity of postoperative follow-up, surgeon's experience), that lead to GERD and HH recurrence and allowed to substantiate the indications for the usage of the developed method of complex diagnosis and treatment.

Conflict of interest
The author of the manuscript attest to the absence of a conflict of interest.
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