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MODERN ASPECTS OF DIAGNOSIS AND SURGICAL TREATMENT OF HIATAL HERNIAS: LITERATURE REVIEW

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ABSTRACT — Laparoscopic correction is the main method of treating hiatal hernias. However, despite more than thirty years of experience, many issues remain controversial and require compilation and standardization. The authors have analyzed the latest scientific studies and recommendations on the treatment of hiatal hernias with a high level of evidence, which is presented in the form of a review with a comparison of their own experience in surgical treatment of 171 patients operated on for hiatal hernias. The risk of transition of an asymptomatic hiatal hernia to a clinically significant one is 1% per year, while observation, rather than active surgical tactics, is indicated. Only symptomatic hernias are subject to surgical treatment. Surgical intervention should include the following mandatory steps: dissection of the esophageal-diaphragmatic ligament with excision of the hernial sac while protecting the branches of the vagus nerve; dissection of both crura of diaphragm, transhiatal mobilization of the esophagus in the mediastinum to achieve the length of its intraabdominal segment of 2–3 cm; if a short esophagus is suspected, a mandatory step is to perform Collis gastroplasty; mobilization of the gastric fundus by dividing gastrointestinal ligament and short gastric arteries; creation of a fundoplication cuff on a calibration probe of at least 30–36 Fr. The choice of the fundoplication and cruroraphia methods did not significantly affect the long-term results of treatment. Laparoscopic interventions are the most effective way to treat patients with hiatal hernias, due to their safety, low trauma, low complication rate and the possibility of rapid rehabilitation of patients. The technique of surgical intervention needs a clarified standardization.

KEYWORDS — hiatal hernia; fundoplication; recurrence; surgical mesh; symptom assessment; treatment failure; laparoscopic correction; diagnosis.

INTRODUCTION

Hiatal hernia is a disease characterized by displacement through the esophageal orifice of the diaphragm into the thoracic cavity of the abdominal esophagus, cardia, upper stomach, and sometimes intestinal loops [1]. Hiatal hernia is a fairly common disease and can often be diagnosed during examinations for a completely different pathology, since in most cases it is absolutely asymptomatic. According to various authors, the detectability of this pathology among the adult population can reach 20–30% [2]. However, the long-term existence of hiatal hernia and the associated trouble of anatomical and functional relationships in the cardioesophageal zone, as a rule, over time leads to the onset of clinical symptoms, primarily associated with the development of gastroesophageal reflux, sometimes dramatically worsening the quality of life of the patient and requiring treatment. The only method of treatment that allows to eliminate the existing hiatal hernia complicated by gastroesophageal reflux disease (GERD), is surgical. The laparoscopic method is currently the gold standard in the treatment of hiatal hernia and GERD [3].

However, despite the almost thirty years of experience with laparoscopic interventions, a number of issues still remains relevant. Such as: whether to operate hiatal hernia and GERD or to treat conservatively, determining the optimal volume and technique of the surgical aid, choosing the method of cruroraphia, the need to use a mesh or biological graft to close a hernial defect or strengthen sutures during plastic surgery of a hiatal hernia, the need to complement plastic surgery of esophageal hiatus by fundoplication or gastropexy [4]. The widespread introduction of laparoscopic techniques and the emergence of a large number of surgical methods for correcting hiatal hernia have not led to the development of a unified approach to the diagnosis and surgical treatment of patients with this pathology.

MATERIAL AND METHODS

The present study analyzes the latest published studies and recommendations on the surgical treatment of hiatal hernia with a high level of evidence, which is presented in the form of a review with a comparison of data from our own retrospective analysis in surgical treatment of 171 patients operated for hiatal

hernias for the period 2009–2018. Indications for surgical treatment were:

- clinically, radiologically and endoscopically confirmed hiatal hernia;
- inefficiency of conservative therapy of gastroesophageal reflux during more than 3 months;
- the presence of clinically significant extraesophageal (cardiac or bronchopulmonary) manifestations of hiatal hernia and associated GERD.

All patients were operated in the scope of laparoscopic cruroraphia with fundoplication. There were 69 men (40.4%) and 102 women (59.6%). The age of the patients ranged from 25 to 74 years, the average age was 54.2 ± 6.1 years. Nissen fundoplication was used in 109 cases, Toupet fundoplication was used in 62 patients. In 29 patients with a hernia defect size of 5 cm and larger, suture cruroraphia was supplemented with alloplasty.

Statistical analysis was carried out using the R Studio program Version 1.2.1335© 2009–2019 R Studio, Inc., GPL. Quantitative variables are presented in the form of mean and standard deviation, since they all had a normal distribution (Shapiro-Wilk test). When comparing two independent groups with quantitative variables, the Student's T-test was used. Nominal and ordinal variables are represented as percentages. To compare the nominal scales, the Pearson criterion was applied if no more than 20% of the expected frequencies were less than 5, otherwise the exact Fisher criterion was applied.

LITERATURE REVIEW

The formation of approaches to the treatment of patients suffering from hiatal hernia had several stages. Initially, most surgeons adhered to active surgical tactics when detecting hiatal hernia, justifying the need for surgical intervention by prevention of severe complications associated with ischemia in the hernial sac. However, in 2002, the publication of the Stylopoulos study [5] showed that when choosing the tactics of monitoring patients with this pathology, the frequency of the need for urgent intervention was 1.1%, and the quality of life was lower in the group of routinely operated hiatal hernias compared with the observation group. At the same time, a fairly large number of publications appeared in the literature on repeated surgical interventions performed for complications after plastic surgery of hiatal hernia. The appearance and widespread use of drugs of the proton pump inhibitor group allowed to improve the quality of life of patients with hiatal hernia and gastroesophageal reflux as a leading symptom, also at some stage reducing the number of surgical interventions for this

pathology [6]. And yet, the results of studies showed that despite the high cost, laparoscopic hernia plastic surgery with fundoplication had the best indicators of quality of life, especially in the group of patients refractory to antisecretory drugs. All of the above was the reason to make a note in the recommendations of the Association of Gastrointestinal and Endoscopic Surgeons of America (SAGES) that absolutely forbids to operate on patients with sliding (type I) hiatal hernia in the absence of a gastroesophageal reflux manifestations [7]. For paraesophageal hernias, it was noted that when using observational tactics, despite the low percentage of urgent operations (less than 2%), the risk of transformation of an asymptomatic hernia into a symptomatic one is up to 14% per year [8]. Therefore, surgical intervention in fully asymptomatic paraesophageal hernias can be considered individually, taking into account age, concomitant pathology, the risk of surgery and the experience of the operating surgeon. All experts unanimously agree that surgical treatment is indicated for all patients with symptomatic hiatal hernia [9].

Surgical intervention for hiatal hernia includes the following mandatory steps: moving the contents of the hernia into the abdominal cavity, isolation and excision of the hernial sac, mobilization of the lower third of the esophagus in the mediastinum in order to achieve a sufficient length of the esophagus, closure of the esophageal hiatus defect, formation of a fundoplication cuff. The literature describes several variants of cardioesophageal junction mobilization [10, 11]. Some surgeons prefer to start mobilization from the left crus of diaphragm, arguing that with large hernias, the right gastric artery and vein may be located in the hernial sac, which, in case of mobilization from the right crus, may be injured. However, we prefer to start the operation by dissecting the gastro-hepatic ligament and mobilizing the right crus of the diaphragm. When dissecting the gastro-hepatic ligament, in 10–15%, an additional hepatic artery may be found, which, especially in overweight patients, may be quite large, and with a rapid dissection can cause massive bleeding. Regardless of the diameter, this vessel must be coagulated and dissected; attempts to preserve the latter will not allow adequate access to the gastroesophageal junction and will create technical difficulties at the stage of formation of the fundoplication cuff. In no case did the dissection of the accessory hepatic artery affect the course of the postoperative period. Next, one of the tools captures the bottom of the hernial sac and performs traction towards the abdominal cavity. The peritoneum is dissected along the border of the hernial sac along the edge of the esophageal hiatus and then the incision is extended circularly, separating the

left crus of the diaphragm. After the mobilization of the diaphragm crura, usually in a "blunt" way, a tunnel is formed behind the esophagus, into which Penrose drainage or a thin gauze cloth is inserted to carry out traction during further mobilization of the esophagus in the mediastinum. At the same time, during the mobilization of the left semicircle of the esophagus, traction for drainage is carried out towards the right crus of the diaphragm and, accordingly, vice versa. During the mobilization of the esophagus, the diaphragmatic nerves should be identified and traced in order to avoid their trauma [12, 13].

A clear definition of the required length of esophageal mobilization is not described in the literature, it is generally understood that mobilization is carried out until the length of the intraabdominal segment of the esophagus, devoid of tension, is at least 2–3 cm. In order to achieve the required length of the esophagus, some authors cite the length of the esophagus mobilized in the mediastinum from 5 to 10–12 cm, other authors consider it necessary to mobilize it to the level of the lower pulmonary vein. The isolation of the esophagus in the mediastinum should be carried out as close as possible to its adventitious membrane; in this case, the probability of the pleura oozing or injury during mobilization is minimal. Nevertheless, one of the most unpleasant intraoperative complications is the dissection of the esophageal muscle membrane or its perforation at the stage of mobilization [14].

One of the main problems after laparoscopic hiatal hernia surgery is the high frequency of recurrence which ranges from 10% to 40%. In order to improve long-term results, some surgeons, by analogy with the plasty of hernias of the anterior abdominal wall, suggested using mesh prostheses for the plasty of large defects of esophageal hiatus, especially in cases where the closure of the hiatal opening without tension has certain difficulties. The multitude of various materials used for both synthetic and biological transplants and methods of their fixation make certain difficulties in developing a universal protocol for surgical intervention. Almost all meta-analyses published to date note the advantage of using mesh implants in comparison with suture plasty. The largest in the last few years are Tam et al. [15] (2016) who analyzed 13 studies, 1194 patients: 673 with mesh plastic surgery and 521 with suture plastic surgery. The recurrence rate was 13% in the mesh plastic surgery group versus 24% in suture plastic surgery group (HR 0.51, 95% CI 0.30–0.87; $p=0.014$). In a published study by Zhang et al. [16] (2017), where the results of treatment of 719 patients using a mesh implant and 755 with primary suture surgery were analyzed, the recurrence rate was 2.6% vs. 9.4%, respectively (OR 0.23, 95% CI 0.14–0.39,

$p=0.00001$). In a meta-analysis by Sathasivamet al. [17] (2019), the results of treatment of 942 patients were analyzed (mesh plastic surgery — 517 patients, suture microplasty — 425 patients), where the advantage of mesh implant plastic surgery was also noted (OR 0.48, 95% CI: 0.32–0.73, $p<0.05$). In all the above studies, there was no significant difference in the frequency of intraoperative and postoperative complications.

OUR EXPERIENCE AND DISCUSSION

We conducted a retrospective analysis of the results of surgical treatment of 98 patients operated for hiatal hernia, with a hernial defect size of 5 cm or larger for the period 2009–2016. Depending on the method of plastic surgery of the esophageal orifice of the diaphragm, patients were divided into 2 comparison groups. The first group included 69 patients who had hernial defect plastic surgery performed by suture method. The second group included patients who underwent plastic surgery of hiatal hernia using a mesh allograft (29 patients). In the group of cruroplasty with alloplasty, the crura of the diaphragm during stitching were strengthened from the side of the abdominal cavity with a mesh graft, which was located in a V-shape. Analysis of long-term results 5 years after the study showed no advantage of using a mesh graft for plastic surgery of large hiatal hernias in comparison with standard suture plastic surgery both in terms of recurrence rate — 4 (13.8%) vs. 14 (20.3%), CI: 0.19–2.1, $p=0.44$, and in assessing the quality of life according to the GERD-HRQL questionnaire. Therefore, taking into account the likelihood of complications associated with alloplasty, in particular mesh erosion into the esophagus and dysphagia, do not allow us to recommend this method for routine use. Nevertheless, in the case of using the alloplasty technique, we, like most authors, prefer *lightweight* composite prostheses, preferably with an adhesive coating [18]. We do not recommend the circular arrangement of the mesh around the esophagus, as well as the use of a tension-free option, closing the esophageal orifice defect only by the mesh. In order to reduce the likelihood of complications associated with the implantation of a mesh implant, the latter should be located only behind the esophagus in the area of the stitched crura of the diaphragm. We did not note any cases when we bring the crura together and close esophageal orifice in our practice.

Despite the opinion of some authors who question the need for the formation of a fundoplication cuff, we consider this stage mandatory for plastic surgery of hiatal hernia. Indeed, to date, there is no convincing evidence in the literature in favor of the need for the use of fundoplication in plastic surgery of

hiatal hernia. According to some authors, the very formation of the fundoplication cuff, especially when the latter is fixed to the wall of the esophagus and the crura of the diaphragm, creates an additional obstacle to the herniation of the stomach into the mediastinum. There are practically no works in the literature assessing the influence of both the fundoplication cuff itself and the method of its formation on the frequency of relapse in the long-term period. Only some studies provide data in favor of reducing the incidence of pathological reflux in patients with a formed fundoplication cuff. According to our data, 89% of patients with symptomatic hiatal hernia have clinical or endoscopic manifestations of pathological gastroesophageal reflux of varying severity, which dictates the need to perform an antireflux procedure.

The most commonly used antireflux procedure is Nissen fundoplication, which we also prefer to routine use. In its standard form, this technique involves wrapping the gastric fundus around the esophagus by 360°, while the formation of the cuff itself is carried out at the expense of the anterior and posterior walls of the gastric fundus. To do this, the posterior wall of the previously mobilized gastric fundus is captured with a soft clamp from the side of the right crus through the retroesophageal canal, and pulled in the direction of the right crus. The anterior and posterior walls are sewn together in front of the esophagus with 3-4 separate seams with a braided non-absorbable "Ethibond" thread 2-0 or 3-0 for up to 3 cm. In order to prevent dysphagia, the fundoplication cuff should be formed on a thick gastric tube 30-36 Fr. To prevent the formed cuff from slipping off, the anterior semicircle of the esophagus should be caught in two seams. Some authors consider it necessary to fix the upper edge of the fundoplication cuff, as a rule, to the right crus in its upper part. Many surgeons use a variation of this operation described by Rohr S. et al. [19] in 1992 as Floppy Nissen or Nissen-Rosetti in the literature, in which the fundoplication cuff is formed only at the expense of the anterior wall of the stomach without dissecting the gastrosplenic ligament. Initially, this technique assumed the formation of a fundoplication cuff for a length of 4 to 6 cm. Currently, a length of up to 2 cm is considered sufficient, which in the literature has acquired the term Short Floppy Nissen. Despite the results of the meta-analyses conducted by Khatri et al. [20] and Markar et al. [21], which did not reveal significant differences between the above methods in functional results, we are of the opinion that restriction of the mobility of the gastric fundus can cause the formation of a fundoplication cuff with tension and increase the risk of dysphagia or "gas-bloat" syndrome in the long term, which is shown in the meta-analysis

by Engstrom et al. [22], and therefore is not used in our routine practice.

The method competing in the frequency of use with the fundoplication technique is the Toupet method, in which the formed fundoplication cuff envelops the posterior semicircle of the esophagus by 270°, leaving its anterior wall free. One of the latest meta-analyses published by XingDu et al. [23] and comparing the effectiveness of both methods of fundoplication included 1201 patients (8 randomized trials), laparoscopic Nissen fundoplication was performed in 625 patients, Toupet method — in 567 patients. The study showed no differences between the methods in terms of the duration of hospitalization, the frequency of postoperative complications, patient satisfaction with the operation, postoperative heartburn, regurgitation, esophagitis. When performing Nissen fundoplication, a shorter operation time and a higher pressure of the lower esophageal sphincter were noted, and the frequency of dysphagia, gas-bloat syndrome and the frequency of reoperations was higher. However, in the same study, when conducting a subgroup analysis, it was noted that the differences between the methods for dysphagia and gas-bloat syndrome disappeared with an increase in the observation period in the study.

We conducted a retrospective analysis of the results of surgical treatment of 171 patients operated on for hiatal hernia associated with GERD. Depending on the method of fundoplication, patients are divided into 2 groups. The first group consisted of 109 patients, where Nissen fundoplication was used. The second group consisted of 62 patients who had Toupet fundoplication. A comparative analysis of the results of the use of various antireflux techniques showed their equal effectiveness in the short and long term. The choice of the fundoplication method did not affect the duration of surgery, the frequency of intra- and postoperative complications; the proportion of functional dysphagia was 24 (22%) vs. 8 (12.9%), $p=0.14$; the number of unsatisfactory results, in particular, relapse, was 19 (17.4%) vs. 15 (24.2%), $p=0.48$, and of dysphagia — 8 (7.3%) vs. 2 (3.2%), $p=0.27$.

Of particular interest is the appearance of an increasing number of publications devoted to the effectiveness of the use of partial anterior Dor fundoplication (which consists in fixing the anterior wall of the gastric fundus to the anterior semicircle of the esophagus and the crura of the diaphragm) compared with the widespread Nissen and Toupet fundoplications in the aspect of use in hiatal hernia plastic surgery. Broeders et al., in a meta-analysis of surgical treatment of 458 patients, showed the same reflux control with a lower frequency of postoperative dysphagia when performing anterior Dor fundoplication compared with Nis-

sen fundoplication [24]. A retrospective cohort study that was conducted by Trepanier et al. showed that the use of Dor and Nissen fundoplications is equivalent in the effectiveness of reflux control in the plastics of large paraesophageal hernias [25].

The frequency of occurrence of a short esophagus according to the literature varies from 0 to 60%, averaging from 5% to 20%. Thus, Madan et al. [26], citing the experience of 628 patients operated on in the scope of fundoplication, of which 351 patients were operated on for hiatal hernia, noted the absence of the need for esophageal elongation procedures. Nason et al. [[27,28,29], citing the results of surgical treatment of 795 hiatal hernias, performed Collis gastroplasty in 454 (57%) patients.

Early destruction of the fundoplication cuff or the eruption of sutures on the crura of the diaphragm with the development of early recurrence of hiatal hernia is extremely rare and, as a rule, is due to a sharp increase in intra-abdominal pressure caused by vomiting or coughing during the patient's recovery from anesthesia. To prevent these complications, massive antibiotic therapy should be carried out. If the patient has concomitant pulmonary pathology, the cough reflex should also be suppressed. Given the probability of developing postoperative dysphagia of a functional nature, which according to our data and literature data can reach 20–30%, it is generally accepted to gradually switch from liquid to solid food within 4–6 weeks. Many authors do not recommend performing routine radiopaque examinations for patients who do not have any clinical manifestations. We are of the opinion that such a survey is necessary at least once a year.

CONCLUSION

Laparoscopic interventions are the most effective way to treat patients with hiatal hernia complicated by GERD, due to their safety, low trauma, low complication rate and the possibility of rapid rehabilitation of patients. Prevention and reduction of the frequency of complications is possible with the surgeon's clear understanding and knowledge of the subtleties of the surgical intervention. Further generalization and analysis of surgical technique options will allow to create a unified protocol of the surgical intervention and, thereby, improve the outcome in patients with hiatal hernia.

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