

Differentiated approach to hernioplasty of paraesophageal hernias

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The results of surgical treatment of paraesophageal hernias indicate a high recurrence rate, from 15 % to 66 %, with an average follow-up period of 12 to 40 months. The main options for repairing the defect of the esophageal hiatus in the presence of paraesophageal hernia are crurorraphy and mesh-reinforced crurorraphy. Both methods have their own advantages and disadvantages. The criteria for choosing a method have not been specified.

OBJECTIVE — to develop a differentiated approach to the surgical treatment of paraesophageal hernias, taking into account the size of the esophageal hiatus, and to determine its effectiveness.

MATERIALS AND METHODS. The study included 157 patients who were operated on for paraesophageal hernias. They were divided into two groups. The patients in both groups did not exhibit any statistically significant differences in terms of mean age, body mass index, sex ratio, type, frequency of complaints, or results of the endoscopic and radiological examination.

In Group I, hiatoplasty was performed using crurorraphy (61 (38.9 %) patients). In this group, the threshold values of the esophageal hiatus dimensions were calculated using the developed device and methodology, which allowed predicting hernia recurrence during the follow-up period of up to 18 months. In Group II (96 (61.1 %) patients), the hernioplasty technique (crurorraphy or mesh-reinforced crurorraphy) was chosen on the basis of the obtained threshold values.

RESULTS. In Group I, the mean hiatal surface area was 86.8 ± 18.2 mm² (53 to 161 mm²) and the width of the esophageal hiatus was 29.3 ± 3.3 mm (24 to 38 mm). In Group II, they were 95.6 ± 23.2 mm² (51 to 212 mm²) and 31.1 ± 3.7 mm (24 to 43 mm), respectively. The threshold hiatal surface area, at which the probability of recurrence after crurorraphy was > 50 %, was 90 mm² (AUC — 0.926 (95 % confidence interval — 0.827—1.000), with a sensitivity and specificity of 87.5 % and 97.8 %, respectively. The width of the esophageal hiatus was measured at a cut-off point of 32 mm (AUC — 0.864 (95 % confidence interval — 0.733—0.995), with a sensitivity and specificity of 75.0 % and 78.0 %. In Group II, posterior crurorraphy was performed in the case of a hiatal surface area < 90 mm² and a distance between the crura diaphragmatis < 32 mm. In other cases, mesh-reinforced crurorraphy was conducted. The recurrence rate in Groups I and II was 26.2 % and 7.3 % ($p=0.001$).

CONCLUSIONS. The device and methodology that have been developed are capable of measuring the dimensions (length, width, and area) of the esophageal hiatus intraoperatively. These measurements can be taken for the entire area within the esophageal hiatus contour, independent of its shape, even when using laparoscopic methods. The study found that there was a probability of recurrence after crurorraphy > 50 % when the threshold hiatal surface area was 90 mm², and the width of the esophageal hiatus was 32 mm. A differentiated approach to hiatoplasty involves using crurorraphy for hiatal surface areas < 90 mm² or distances between the crura diaphragmatis < 32 mm. For larger hiatal surface areas or widths, mesh-reinforced crurorraphy is indicated. This approach has resulted in a significant reduction in the recurrence rate from 26.2 % to 7.3 % ($p=0.001$) and has prevented complications associated with the use of implants for up to 18 months after surgery.

KEYWORDS

paraesophageal hernia, hiatal surface area, crurorraphy, allohernioplasty, recurrence, prediction, surgical tactics.

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In 1954, N.R. Barrett published a fundamental work in which he proposed to classify acquired hiatal hernias into 4 types according to their anatomical characteristics [8]:

- Type I hernias are sliding hiatal hernias in which the gastroesophageal junction (GEJ) migrates over the diaphragm. The stomach remains in its normal longitudinal position, with the fundus located below the gastroesophageal junction.

- Type II hernias are true paraesophageal hernias. The gastroesophageal junction remains in the normal anatomical position, while part of the gastric fundus is adjacent to the esophagus through the diaphragmatic hiatus.

- Type III hernias are a combination of types I and II, with both the esophagus and the gastric fundus bulging through the hiatus. The gastric fundus lies above the gastroesophageal junction.

- Type IV hernias are distinguished by the presence of a structure inside the hernial sac other than the stomach, such as the omentum, colon, or small intestine.

It is believed that more than 95 % of diagnosed hiatal hernias are type I. More than 90 % of type II–IV hernias are type III, and the least common is type II [24].

Regardless of the access method (laparotomy, laparoscopy, or thoracotomy), surgical treatment for paraesophageal hernias entails opening the hernial sac, reducing the hernia contents back into the abdominal cavity, and excising the sac [44] without exposing the crura diaphragmatis [2, 14]. It also involves complete mobilisation of the oesophagus 360° to the level of the lower pulmonary veins, hiatoplasty, fundoplication, or the Collis gastroplasty [38].

The results of surgical treatment of paraesophageal hernias indicate a high recurrence rate due to failure of hiatoplasty, from 15 % to 66 %, with an average follow-up period of 12 to 40 months [6, 16, 23, 29, 31, 35]. The main options for repairing the defect of the esophageal hiatus are crurorraphy and mesh-reinforced crurorraphy. Both methods have their own advantages and disadvantages. The criteria for choosing a method have not been specified.

OBJECTIVE — to develop a differentiated approach to the surgical treatment of paraesophageal hernias, taking into account the size of the esophageal hiatus, and to determine its effectiveness.

Materials and methods

The study included 157 patients who were operated on for paraesophageal hernias. The research consisted of two stages. The first stage involved evaluating the impact of the size of the esophageal hiatus on

the incidence of hernia recurrence over an extended period after crurorraphy, as well as the justification for using allografts. We measured the width of the esophageal hiatus (the maximum distance between the crura diaphragmatis), the length (from the crural adhesion at the bottom to the upper border of the hernia defect), and the hiatal surface area.

The second stage included the study of the long-term results of hernioplasty using a differentiated approach to cruroplasty, developed on the basis of the data obtained during the first stage of surgical treatment.

Group I included 61 (38.9 %) patients who received treatment at the first stage, while Group II included 96 (61.1 %) patients who underwent treatment according to a differentiated approach.

The long-term results of the operations were monitored for up to 18 months. Radiological esophagography with barium sulphate was used.

The dimensions of the esophageal hiatus were measured after the contents of the hernial sac were reduced into the abdominal cavity and the esophagus was mobilised. In open operations, we used the modified method presented by H. F. Batirel et al. [9]. The esophageal hiatus was photographed against a 10 mm long standard, and the image was transferred to a computer screen with a millimetre grid scaled to the standard. The hiatal surface area was calculated in square millimetres, and the length and width of the esophageal hiatus were measured in millimetres.

During laparoscopic interventions, intraoperative measurement of the dimensions of the esophageal hiatus was performed using a designed device [42] and the corresponding software (Fig. 1).

All patients in both groups underwent endoscopic and radiological examinations.

The endoscopic examination was performed using a Fujinon EG 760-R fibrogastroduodenoscope under intravenous sedation (propofol) in the patient's left side position. The endoscope measured 0.92 cm in diameter. The cardinal sign of a hiatal hernia was the presence of gastric mucosa above the crural impression by more than 2 cm.

The X-ray examination was performed using the Winscope Plessart EX8 universal X-ray system with remote control (Toshiba). The examination included a polypositional examination of the direct, lateral, and oblique anterior and posterior projections in the upright position and Trendelenburg position, followed by an examination of the initial upright position with normal breathing, deep breathing, and the Valsalva manoeuvre.

The study was conducted in compliance with the Declaration of Helsinki [46]. The study protocol was approved by the ethics committee of

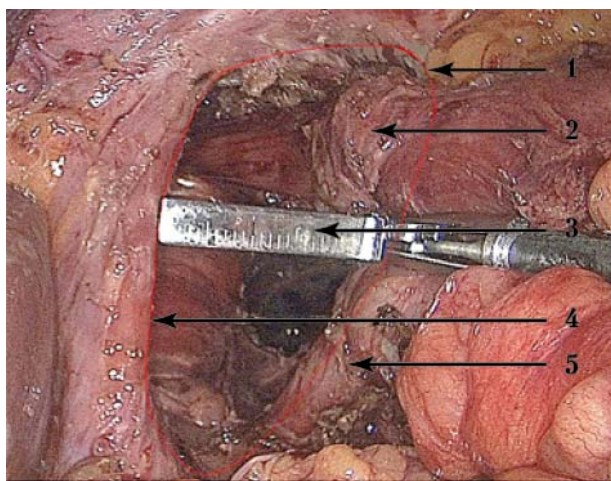


Figure 1. Location of the laparoscopic instrument scale in the hiatal area (the hiatal surface area – 9.43 mm², the length of the esophageal hiatus – 48 mm, and the width of the esophageal hiatus – 27 mm): 1 – esophageal hiatus contour; 2 – esophagus; 3 – instrument scale; 4 – right crura diaphragmatis; 5 – left crura diaphragmatis

Table 1. Group characteristics

Variable	Group I (n = 61)	Group II (n = 96)
Age, years	52.3 ± 10.9	54.1 ± 10.1
Male	25 (41.0 %)	34 (35.4 %)
Female	36 (59.0 %)	62 (64.6 %)
Body mass index, kg/m ²	26.8 ± 2.5	27.4 ± 2.7
Disease duration, months	58.6 ± 49.5	59.3 ± 53.7
Heartburn	35 (57.4 %)	51 (53.1 %)
Chest pain	20 (32.8 %)	40 (41.7 %)
Belching	27 (44.3 %)	41 (42.7 %)
Nausea	38 (62.3 %)	55 (57.3 %)
Hoarseness	26 (42.6 %)	45 (46.9 %)
Cough	12 (19.7 %)	24 (25.0 %)
Dysphagia	21 (34.4 %)	32 (33.3 %)
Hiccups	11 (18.0 %)	21 (21.9 %)
Odynophagia	11 (18.0 %)	13 (13.5 %)
Vomiting	10 (16.4 %)	19 (19.8 %)
Feeling of fullness after meal	21 (34.4 %)	36 (37.5 %)
Weight loss	15 (24.6 %)	25 (26.0 %)
Arrhythmia	19 (31.1 %)	34 (35.4 %)
Dyspnea	20 (32.8 %)	28 (29.2 %)

All $p > 0.05$.

Bogomolets National Medical University (protocol No. 160 of September 26, 2022).

According to the X-ray examination, hernia recurrence (anatomical recurrence) was defined as the migration of the gastroesophageal junction above the diaphragm. We distinguished the displacement of the gastroesophageal junction as < 2 cm and ≥ 2 cm.

At the first stage, laparotomy was used in 27 (44.3 %) patients, laparoscopy in 18 (29.5 %), and thoracotomy in 16 (26.2 %). At the second stage, the operation was performed using a laparoscopic approach.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics. Discriminant statistics were calculated. The mean values are presented as the arithmetic mean and standard deviation ($M \pm SD$). A comparison of the mean values of quantitative variables was performed using the Mann-Whitney U-test or Student's t-test, depending on the distribution of the variable. Relative values were compared using Pearson's χ^2 test.

Binary logistic regression analysis was performed to determine the probability of an event occurring depending on the values of the variable. ROC analysis was used to assess the quality of classification models.

The null hypothesis of equality of variables was rejected at $p < 0.05$.

Results

The patients in both groups did not exhibit any statistically significant differences in terms of mean age, body mass index, sex ratio, type, or frequency of complaints (Table 1).

There was also no statistically significant difference between the groups in terms of instrumental research indicators (Table 2).

In Group I, the average length of the esophageal hiatus was 54.8 ± 5.4 mm (46–65 mm), the width of the esophageal hiatus was 29.3 ± 3.3 mm (24–38 mm), and the hiatal surface area was 86.8 ± 18.2 mm² (53–161 mm²).

Within 18 months, anatomical recurrence was recorded in 16 (26.2 %) patients, including 10 (16.4 %) patients with a gastroesophageal junction > 2 cm above the diaphragm and 6 (9.8 %) patients with a gastroesophageal junction from 1 to 2 cm.

The recurrence rate did not depend on the surgical approach ($p = 0.703$) (Table 3).

Univariate bivariate logistic regression analysis showed a statistically significant dependence of recurrence rate on the area and width of the esophageal hiatus.

Table 2. **Results of the endoscopic and radiological examination**

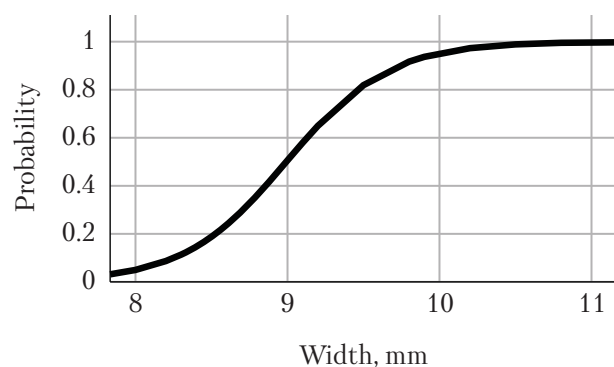
Variable	Group I (n = 61)	Group II (n = 96)
Endoscopic examination		
Esophagitis	40 (65.6 %)	58 (60.4 %)
Erosive esophagitis, stage*		
A	6 (16.7 %)	6 (11.3 %)
B	16 (44.4 %)	21 (36.9 %)
C	10 (27.8 %)	20 (37.7 %)
D	4 (11.1 %)	6 (11.3 %)
Erosive gastritis	10 (16.4 %)	19 (19.8 %)
Peptic ulcer	6 (9.8 %)	8 (8.3 %)
Cameron's ulcer	2 (3.3 %)	6 (6.3 %)
Radiological examination		
Reducibility		
Non-reducible hernia	48 (78.7 %)	80 (83.3 %).
Partially reducible hernia	13 (21.3 %)	16 (16.7 %)
Hernia size		
Cardiofundal hernia	34 (55.7 %)	66 (68.8 %)
Subtotal hiatal hernia	26 (42.6 %)	27 (28.1 %)
Total hiatal hernia	1 (1.6 %)	3 (3.1 %)

All $p > 0.05$.

* According to the LA Classification System.

Table 3. **Hernia recurrence rate depending on the access method**

Surgical access method	Total number	Recurrence
Laparotomy	27	6 (22.2 %)
Laparoscopy	18	6 (33.3 %)
Thoracotomy	16	4 (25.0 %)
Total	61	16 (26.2 %)

Figure 2. **Probability of hernia recurrence depending on the hiatal surface area**

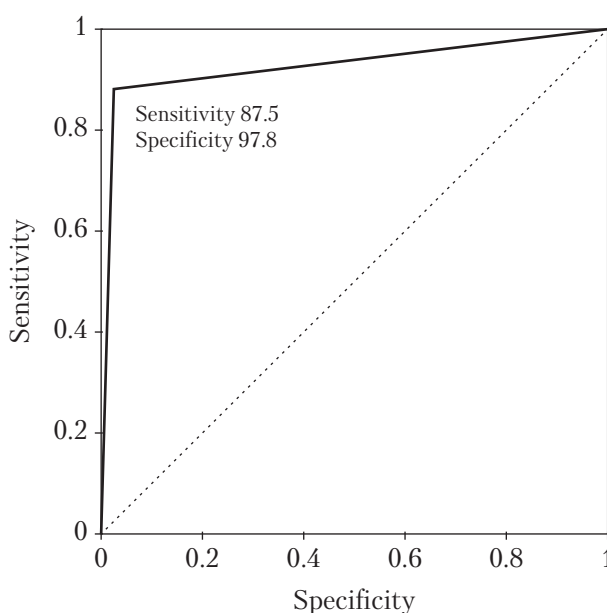
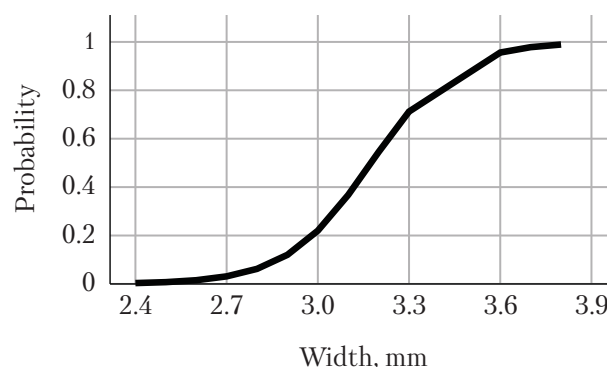
The cut-off point at which an increased probability of recurrence was predicted depending on the hiatal surface area (> 0.5) was 90 mm² (Fig. 2).

The test proved to be effective, as evidenced by the area under the ROC curve (AUC) of 0.926 (95 % confidence interval (CI) – 0.827–1.0) (Fig. 3). The sensitivity was 87.5 % and the specificity was 97.8 %.

The cut-off point for predicting an increased probability of recurrence based on the width of the esophageal hiatus (> 0.5) was 32 mm (Fig. 4).

The test was effective (AUC – 0.864 (95 % CI – 0.733–0.995) (Fig. 5). The sensitivity was 75.0 % and the specificity was 78.0 %.

According to the logistic regression analysis, the length of the esophageal hiatus did not statistically significantly affect the recurrence rate.

Figure 3. **ROC curve for predicting the probability of recurrence at a hiatal surface area of 90 mm²**Figure 4. **Probability of hernia recurrence depending on the width of the esophageal hiatus**

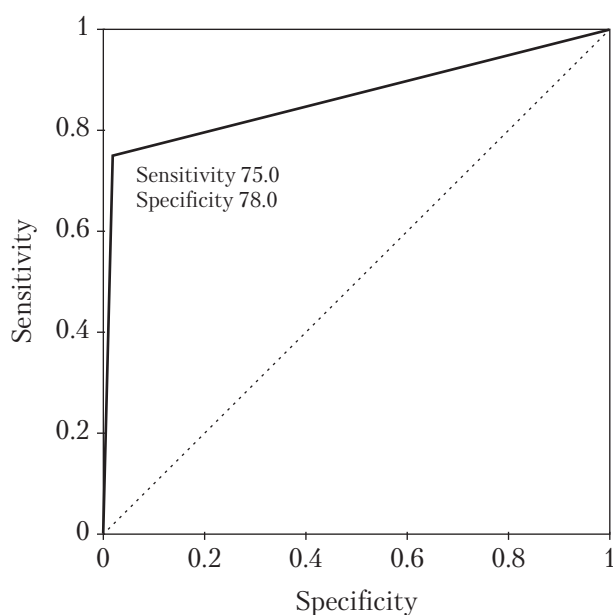


Figure 5. ROC curve for predicting the probability of recurrence at a width of 32 mm

In the regression logistic binary analysis of the two variables «the hiatal surface area» and «the width of the esophageal hiatus», only «the hiatal surface area» was an independent prognostic factor for the occurrence of hernia recurrence. The null hypothesis's error concerning the coefficient for the indicator «the width of the esophageal hiatus» is $p = 0.07$.

Taking into account the data obtained from the analysis of results in Group 1, we used a differentiated approach to hernioplasty in Group II. It consisted of reducing the hernia into the abdominal cavity, mobilising the esophagus at least 3 cm below the diaphragm, and intraoperatively determining the dimensions of the esophageal hiatus according to the developed methodology. In the case of a hiatal surface area $< 90 \text{ mm}^2$ and a distance between the crura diaphragmatis $< 32 \text{ mm}$, posterior crurorraphy was performed. In the case of a hiatal surface area $\geq 90 \text{ mm}^2$ and/or a distance between the crura diaphragmatis $\geq 32 \text{ mm}$, posterior crurorraphy was reinforced with a U-shaped mesh (Parietex Composite Mesh, Polyester with Absorbable Collagen Film, Covidien) with dimensions of $90 \times 80 \text{ mm}$. The mesh was fixed to the crura diaphragmatis using a stapler (Endo Universal 65 Auto Suture (Universal Hernia Stapler) $12.0 \times 4.0 \text{ mm}$, Covidien). All patients underwent a Nissen fundoplication.

For the required indications, 40 (41.7 %) patients underwent posterior crurorraphy, whereas 56 (58.3 %) received mesh-reinforced crurorraphy.

Although the area and width of the esophageal hiatus in Group II were larger than in Group I:

$95.6 \pm 23.2 \text{ mm}^2$ (51 mm^2 to 212 mm^2) versus $86.8 \pm 18.2 \text{ mm}^2$ (53 mm^2 to 161 mm^2) and $31.1 \pm 3.7 \text{ mm}$ (24 mm to 43 mm) versus $29.3 \pm 3.3 \text{ mm}$ (24 mm to 38 mm), the number of recurrences within 18 months was significantly lower (7 (7.3 %) versus 16 (26.2 %), $p = 0.001$). At the same time, in patients who received crurorraphy, recurrence occurred in 2 (5.0 %) instances versus 5 (8.9 %) cases with mesh ($p = 0.465$).

In Group II, the gastroesophageal junction was located $> 2 \text{ cm}$ above the diaphragm in only 2 (2.1 %) patients and at a distance of 1 to 2 cm in 5 (5.2 %).

During the 18-month follow-up, no mesh-related complications were detected.

Thus, a differentiated approach to selecting the cruroplasty method for paraesophageal hernia treatment, which is based on the dimensions of the esophageal hiatus and the personalised use of implants, dramatically reduced the recurrence rate 12–18 months after surgery.

Discussion

Cruroplasty is an integral part of the surgical treatment of paraesophageal hernias and the main preventive measure against recurrence. Various options for closing the defect of the esophageal hiatus have been described, including the reduction of the crura diaphragmatis with sutures, which are mainly placed behind the esophagus (posterior crurorraphy), mesh implantation (absorbable or non-absorbable), and combinations of crurorraphy with mesh implantation [1, 4, 32, 39, 43].

The use of crurorraphy was associated with a high recurrence rate. Thus, according to P.A. Le Page et al., after 455 operations for paraesophageal hernias, mainly using crurorraphy (in 94 %), the rate of anatomical recurrence ($< 2 \text{ cm}$ and $\geq 2 \text{ cm}$) in the period up to 1 year was 13.7 %, in 5–10 years — 40.1 %, over 10 years — 50.0 %, and the recurrence rate ($\geq 2 \text{ cm}$) was 3.4 %, 9.5 %, 13.8 % and 25.0 %, respectively [28].

Many studies have reported a decrease in the hernia recurrence rate after hernioplasty with implants compared to crurorraphy in short-term follow-up [19, 20, 25, 37].

Subsequently, it was shown that the additional use of mesh compared to crurorraphy reduces the recurrence rate at different times of the postoperative period to 0.8–9 % versus 22.2–26 % without mesh [7], to 12.1 % versus 20.5 % [34], to 3.7 % versus 6 % [41], and in the case of giant hernias, to 35 % versus 77 % [33].

At the same time, implantation of a foreign body in the area of the esophageal hiatus, along with enhancing the stability of hernia defect closure, can have

negative consequences (wrinkling, mesh migration, infection (abscesses, fistulas), cardiac tamponade, erosion of the aorta, esophagus or stomach, esophageal stenosis, severe dysphagia, fibrous reaction that can complicate a new esophageal surgery), so some surgeons refrain from using mesh even in giant paraesophageal hernias [10, 15, 18, 17, 25, 34, 37, 40].

Recently, a number of multicentre prospective studies and meta-analyses have been conducted that have not found statistically significant differences in the recurrence rate after crurorraphy compared with mesh-reinforced crurorraphy, although in most of them the recurrence rate was lower in the case of mesh, but the difference was not statistically significant [5, 13, 36, 45]. For example, a meta-analysis in 2024, which included 34 studies (6 randomised clinical trials, 25 retrospective studies and 3 prospective cohort studies) and included 2170 patients after laparoscopic treatment of hiatal hernia, found the following recurrence rates: after crurorraphy — 20.8%, after absorbable mesh reinforcement — 20.6%, after non-absorbable mesh reinforcement — 13.7%. The average follow-up period was 25.8 ± 16.4 months, 28.1 ± 13.8 months and 30.8 ± 15.3 months, respectively [27]. The Brazilian Society for Abdominal Wall Hernias notes in its guidelines for the management of patients with large paraesophageal hernias that the use of non-absorbable prostheses effectively prevents anatomical recurrence in the short-term follow-up, but long-term evidence is still lacking [11].

Thus, the question of indications for the use of mesh in paraesophageal hernias remains open and requires further research.

F. A. Granderath et al. first implemented the idea of performing mesh-reinforced crurorraphy at specific sizes of the hiatal surface area [21]. They developed an intraoperative method for calculating the hiatal surface area, which in hiatal hernias was on average 50.92 mm^2 , and divided patients into three categories. The authors suggested crurorraphy for patients with a hiatal surface area up to 40 mm^2 , from 40 to 80 mm^2 — reinforcement with 1–3 cm mesh, $> 80 \text{ mm}^2$ — tension-free cruroplasty using the in-lay technique with ePTFE mesh.

O. O. Koch et al. also determined the average hiatal surface area in patients undergoing laparoscopic hiatoplasty (according to the method of F. A. Granderath et al.), which was higher than in the previous study — 81.9 mm^2 (from 56.1 to 160.9 mm^2). According to the authors, the esophageal hiatus with an area of at least 56.0 mm^2 should be indicated for mesh hiatoplasty [25].

V. V. Grubnik et al. [22] used ANOVA analysis of variance to determine the threshold hiatal surface

area for mesh-reinforced crurorraphy. The area was measured using the method developed by F. A. Granderath et al. The authors divided hernias into three categories: $< 100 \text{ mm}^2$ (small hernias), 100 to 200 mm^2 (large hernias), and $> 200 \text{ mm}^2$ (giant hernias). For additional mesh applications, the threshold area was $> 100 \text{ mm}^2$. In the case of a hiatal surface area of 100 – 200 mm^2 , a light, partially absorbable mesh was suggested, and in the case of a hiatal surface area $> 200 \text{ mm}^2$, a non-absorbable mesh was used according to the original method [22]. Dispersion analysis does not directly allow determining the threshold values (in this case, the hiatal surface area) for a particular situation (in this case, the probability of recurrence), but it does allow confirming the correctness of the selected threshold levels, which the researchers determined based on their own experience.

To determine the impact of the measurements of the esophageal hiatus on the incidence of paraesophageal hernia recurrence and to justify the indications for mesh use, we developed a device and method for calculating the size (length, width, and surface area), including in the case of laparoscopic access. This method is more accurate than other intraoperative methods (the method developed by F. A. Granderath et al. and the estimation of the hiatal surface area by the size of a rhombus [11]) because it considers the entire area within the esophageal hiatus contour, regardless of shape. Binary logistic regression analysis was used to calculate the thresholds, which allows us to estimate the probability of recurrence at any size of the hiatal surface area available in the study. The test was evaluated for its sensitivity and specificity using the ROC curve. In the examination of 61 patients who underwent crurorraphy for esophageal hernia, the mean value of the hiatal surface area was $86.8 \pm 18.2 \text{ mm}^2$ (from 53 mm^2 to 161 mm^2), which approximately corresponds to the findings presented by O. O. Koch et al. [25]. In the period up to 18 months after surgery, anatomical recurrence was recorded in 16 (26.2%) patients, including 10 (16.4%) patients with a gastroesophageal junction $\geq 2 \text{ cm}$ above the diaphragm and 6 (9.8%) patients with a gastroesophageal junction from 1 to 2 cm above the diaphragm.

The cut-off point at which an increased probability of recurrence was predicted depending on the hiatal surface area was 90 mm^2 (AUC 0.926 (95% CI 0.827–1.0); sensitivity and specificity were 87.5% and 97.8%, respectively). This hiatal surface area value is larger than that reported by F. A. Granderath et al. [21] and O. O. Koch and et al. [25], but smaller than that found by V. V. Grubnik et al. [22]. Another important factor in recurrence was the width of the esophageal hiatus, with a cut-off point

of 32 mm (AUC — 0.864 (95 % CI: 0.733–0.995), the sensitivity and specificity were 75.0 % and 78.0 %, respectively.

In a prospective group (96 patients), we evaluated a differentiated approach to hiatoplasty for up to 18 months. In the case of a hiatal surface area > 90 mm² or a distance between the crura diaphragmatis > 32 mm, the posterior crurorraphy was reinforced with a U-shaped mesh (Parietex Composite Mesh, Polyester with absorbable Collagen Film, Covidien) with dimensions of 90 × 80 mm. In other cases, posterior crurorraphy was performed. In this group, the recurrence rate was statistically significantly lower (7.3 % vs. 26.2 % in the crurorraphy group, $p = 0.001$). No complications associated with the use of implants were recorded in any case.

Thus, the acquired data suggest that this type of mesh can be effectively used in hiatoplasty procedures for patients with paraesophageal hernias with a hiatal surface area > 90 mm² or a distance between the crura diaphragmatis > 32 mm. In other cases, crurorraphy is appropriate.

Conclusions

The device and method that have been developed are capable of measuring the dimensions (length, width, and area) of the esophageal hiatus intraoperatively. These measurements can be taken for the entire area within the esophageal hiatus contour, independent of shape, even when using laparoscopic methods.

Among patients with paraesophageal hernias who underwent crurorraphy, the recurrence rate within 18 months was 26.2 %. In 10 cases (16.4 %), the gastroesophageal junction was located more than 2 cm above the diaphragm, while in 6 cases (9.8 %), it was positioned 1 to 2 cm above.

The study found that there was a probability of recurrence after crurorraphy > 50 % when the threshold hiatal surface area was 90 mm² (AUC 0.926 (95 % CI 0.827–1.0), with a sensitivity and specificity of 87.5 % and 97.8 %, respectively. The cut-off point based on the width of the esophageal hiatus was 32 mm (AUC 0.864 (95 % CI 0.733–0.995), with a sensitivity and specificity of 75.0 % and 78.0 %, respectively.

A differentiated approach to hiatoplasty involves using crurorraphy for hiatal surface areas < 90 mm² or distances between the crura diaphragmatis < 32 mm. For larger hiatal surface areas or widths, mesh-reinforced crurorraphy is indicated. This approach has resulted in a significant reduction in the recurrence rate from 26.2 % to 7.3 % ($p = 0.001$) and has prevented complications associated with the use of implants for up to 18 months after surgery.

DECLARATION OF INTERESTS

The authors declare that they have no conflicts of interest.

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AUTHORS CONTRIBUTIONS

Conception and design of the study — O. Y. Ioffe, T. A. Tarasov; collection and analysis of data — T. A. Tarasov, M. M. Bagirov, statistical analysis — T. A. Tarasov, L. Y. Markulan; writing the manuscript — T. A. Tarasov; critical revision — O. Y. Ioffe, T. A. Tarasov, L. Y. Markulan.

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Хірургічне лікування параезофагеальних гриж із використанням диференційованого підходу до герніопластики

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Результати хірургічного лікування параезофагеальних гриж (ПЕГ) асоціюються з високою частотою рецидивів (від 15 % до 66 %) при середньому періоді спостереження від 12 до 40 міс. Основні методики усунення дефекту стравохідного отвору діафрагми (СОД) при ПЕГ — шовна крурорафія (ШК) та ШК з армуванням швів сітчастим імплантатом мають переваги та недоліки. Критеріїв вибору методу не розроблено.

Мета — розробити диференційований підхід до хірургічного лікування параезофагеальних гриж з урахуванням параметрів стравохідного отвору діафрагми та визначити його ефективність.

Матеріали та методи. Прооперовано 157 хворих із ПЕГ, яких розподілили на дві групи. Хворі обох груп статистично значущо не відрізнялися за середнім віком, індексом маси тіла, співвідношенням статей, характером і частотою скарг, показниками ендоскопічного та рентгенологічного дослідження. У групі І пластику СОД здійснювали за допомогою ШК (61 (38,9 %) хворий). У цій групі розраховували з використанням розробленого пристрою і методики порогові значення параметрів СОД, які давали змогу прогнозувати рецидив грижі за період спостереження до 18 міс. У групі ІІ (96 (61,1 %) хворих) методику герніопластики (ШК або армування ШК сіткою) обирали на підставі отриманих порогових значень.

Результати. Середня площа СОД у групі І становила $(86,8 \pm 18,2)$ мм² (від 53 до 161 мм²), ширина СОД — $(29,3 \pm 3,3)$ мм (від 24 до 38 мм), у групі ІІ — відповідно $(95,6 \pm 23,2)$ мм² (від 51 до 212 мм²) та $(31,1 \pm 3,7)$ мм (від 24 до 43 мм) відповідно. Порогова площа СОД, за якої ймовірність рецидиву після ШК > 50 %, — 90 мм² (AUC — 0,926 (95 % довірчий інтервал — 0,827—1,000), чутливість і специфічність тесту — відповідно 87,5 та 97,8 %), та ширина СОД із точкою відсічення 32 мм (AUC — 0,864 (95 % довірчий інтервал — 0,733—0,995), чутливість і специфічність тесту — 75,0 та 78,0 %). У групі ІІ у разі площі СОД < 90 мм² та відстані між ніжками діафрагми < 32 мм виконували задню ШК, в інших випадках ШК армували сітчастим імплантатом. Частота рецидивів у групах І та ІІ становила 26,2 і 7,3 % ($p = 0,001$).

Висновки. Розроблений пристрій і методика розрахунку параметрів СОД, зокрема в разі лапароскопічного доступу, дає змогу інтраопераційно врахувати площу в межах контуру СОД незалежно від його форми, а також довжину і ширину СОД. Порогова площа СОД, за якої ймовірність рецидиву після ШК перевищує 50 % — 90 мм², ширина СОД — 32 мм. Диференційований підхід до пластики СОД передбачає виконання лише ШК у разі площі СОД < 90 мм² або відстані між ніжками діафрагми < 32 мм, а також армування ШК сіткою у випадку розмірів площі СОД або його ширини, що перевищують зазначені. Цей підхід дав змогу зменшити частоту рецидивів із 26,2 до 7,3 % ($p = 0,001$) та уникнути ускладнень, пов'язаних із використанням імплантатів, протягом 18 міс після операції.

Ключові слова: параезофагеальна грижа, площа стравохідного отвору діафрагми, шовна крурорафія, алогерніопластика, рецидив, прогнозування, хірургічна тактика.

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