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Efficacy of the ERAS strategy in patients with type III–IV paraesophageal hernias

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ERAS (Enhanced Recovery After Surgery) protocols have demonstrated efficacy across numerous surgical specialties; however, their effectiveness has not been evaluated in patients with paraesophageal hernias (PEH).

Objective — to determine the efficacy of the ERAS strategy in patients with type III—IV PEH undergoing laparoscopic surgery.

Materials and methods. The study was conducted at the Department of General Surgery No 2 of Bogomolets National Medical University from 2017 to 2023, involving 114 patients who underwent laparoscopic hernioplasty for Type III—IV PEH. The ERAS strategy was applied in 96 patients (main group — Group M) and not applied in 18 patients (comparison group — Group C). The efficacy of the ERAS protocol was evaluated by comparing average hospital stay, hunger, thirst, general weakness, and depression levels using a 10-point visual analogue scale (0 = «no concern,» 10 = «severe concern»), as well as the frequency of nausea, vomiting, abdominal distention, passage of gas, and bowel movement within the first postoperative day.

Results. Group M showed lower average scores for «general weakness», «hunger», and «thirst» by factors of 1.43, 1.35, and 1.34, respectively, compared to Group C. The application of the ERAS protocol positively influenced bowel function recovery: on the first postoperative day, the proportion of patients with gas passage was higher in Group M than in Group C (78.1 % vs. 55.6 %), while the incidence of abdominal distention was lower (2.1 % vs. 16.7 %). Bowel movement was observed in 51.0 % of patients in Group M compared to 27.8 % in Group C. These positive outcomes associated with the ERAS protocol contributed to a reduced average hospital stay of 1.72 ± 0.76 days compared to 2.33 ± 0.91 days in the control group.

Conclusions. The use of the ERAS protocol in patients undergoing laparoscopic surgery for type III—IV paraesophageal hernia demonstrated significant advantages in the early postoperative period. Patients reported significantly less «general weakness», «feeling of hunger», and «feeling of thirst» compared to the control group. Improved bowel function recovery was recorded, evidenced by a higher proportion of patients with gas passage and bowel movements and a significantly lower proportion of patients with abdominal distension, as well as a reduced average length of hospital stay. The obtained results confirm the feasibility of implementing the ERAS protocol to improve postoperative recovery and reduce postoperative complications in patients with type III—IV paraesophageal hernia.

Keywords
type III—IV paraesophageal hernia, surgical treatment, laparoscopic approach, ERAS protocol, outcomes.

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The ERAS (Enhanced Recovery After Surgery) protocol is a modern approach to perioperative patient management aimed at accelerating recovery, reducing complications, and shortening hospital stay duration [8, 10, 16, 20]. This protocol includes a series of evidence-based strategies and recommendations to optimize all aspects of surgical care [7, 22, 18].

ERAS protocols were developed by a group of European surgeons in 2001 [4]. The main aspects of the concept include a multidisciplinary team working with the patient, a multimodal approach to addressing issues that delay recovery and cause complications, an evidence-based approach to protocols, and changes in management utilizing interactive and continuous feedback [9].

The ERAS strategy has been implemented as a primary focus in the care of surgical patients across all stages of treatment (in outpatient clinics, preoperative departments, operating rooms, postoperative recovery departments, and wards).

ERAS protocols have proven effective in many surgical specialties, including in the surgical treatment of giant ventral hernias [5], colorectal surgery [1, 11], pancreatic surgery [14], gynecology [2, 15], urology [17], bariatric surgery [19], and others. They contribute to better treatment outcomes, reduce complications, and shorten hospital stays, which decreases overall healthcare costs. However, the effectiveness of the ERAS strategy has not been evaluated for patients with paraesophageal hernias (PEH), who are characterized by a higher average age, a greater prevalence of chronic vascular, heart, lung, kidney, and gastrointestinal diseases, and, in most cases, excess body weight and obesity.

Objective — to determine the effectiveness of the ERAS strategy in patients with type III—IV PEH who underwent laparoscopic surgery.

Materials and methods

The study was conducted at the Department of General Surgery No 2 of Bogomolets National Medical University from 2017 to 2023, involving 114 patients who underwent laparoscopic hernioplasty for type III—IV PEH. The ERAS strategy was applied in 96 patients (main group).

The following measures were included in the main principles of the ERAS protocol for patients with PEH:

- informing the patient about the specifics of the surgical procedure, postoperative period, and dietary behavior after surgery;
- use of minimally invasive methods (laparoscopic access);
- avoidance of mechanical bowel cleansing;
- pain prevention using multimodal analgesia (Table 1) and local infiltration anesthesia in the area of trocar access points;
- gastroprotection using proton pump inhibitors;
- absence of abdominal cavity drainage;
- reduction of stress response through the use of glucocorticoids;
- prevention of infectious complications (antibiotic prophylaxis, antiseptic washing of trocar wounds);
- prevention of thromboembolic complications (LMWH);
- early patient mobilization — verticalization within 1—2 h after surgery;
- prevention of nausea and vomiting, particularly through the planned administration of ondansetron on the first postoperative day;
- nutrition: intake of a carbohydrate mixture 2 h before surgery and postoperative sipping 6 h after;
- discharge from the hospital at the earliest possible time.

Before surgery. No later than 2 h before the operation, all patients received 200 ml of warm, boiled water with 5 g of glucose to:

- reduce the preoperative fasting period, as well as feelings of hunger and thirst;
- alleviate preoperative anxiety;

Table 1. **Multimodal anesthesia scheme for patients with type III—IV Paraesophageal hernias**

Time of administration, duration	Drug	Dosage, route of administration
30—45 min before surgery	Atropine	0.5—1.0 mg intramuscularly
	Dimedrol	10 mg intramuscularly
	Acetaminophen	1000 mg IV over 15 min
20 min before tracheal intubation	Dexamethasone	8 mg intravenously
After tracheal intubation to the first incision	Bupivacaine 0.25 %	10—30 ml local infiltration anesthesia
During surgery	Sevoflurane	Inhalation, 1 L/min
20—30 min before the end of surgery	Acetaminophen	1000 mg intravenously
After surgery		
1st—3rd day	Acetaminophen	1000 mg intravenously 4 times daily
1st—3rd day	Dexketoprofen	50 mg intravenously as needed
5 days	Diclofenac	50—100 mg once daily rectally
1st—2nd day (for high-intensity pain)	Nalbuphine	10—20 mg intravenously

• decrease the risk of postoperative insulin resistance;

• avoid anesthesia-related risks (regurgitation), as this amount of liquid completely leaves the stomach within 2 hours;

• enhance the anabolic effect in the early postoperative period by reducing postoperative nitrogen loss and protein depletion, as well as maintaining postoperative body weight and muscle function.

In the early postoperative period, 2 hours after extubation, the patient begins to drink water, and after 6 hours, postoperative sipping is initiated (the patient was given a protein mixture of 125 ml). This mixture is high in protein — 18 g per 125 ml — and has a high caloric value of 306 kcal per 125 ml. It also contains vitamins and trace elements (including selenium, chromium, etc.), is fiber-free, and is gluten-free.

Criteria for evaluating treatment outcomes

The effectiveness of ERAS protocol implementation was evaluated based on the average length of hospital stay and the total score according to the Clavien-Dindo classification, as well as feelings of hunger, thirst, general weakness, and depression, assessed on a 10-point visual analogue scale (0 points — «does not bother», 10 points — «bothers significantly»). Additional factors included the frequency of nausea, vomiting, abdominal distension, gas passage, and the presence of bowel movements on the first postoperative day.

Basic methods of mathematical statistics were used for statistical analysis of the study results: descriptive statistics and paired comparisons. Distribution normality was checked for deviations using the Shapiro-Wilk test (when $n < 30$) or the Pearson chi-square test (when $n \geq 30$). For paired comparisons, parametric tests (Student's t-test and Fisher's F-test) were applied if the distribution was normal; if the distribution differed from normal, a non-parametric test (Mann-Whitney U test) was used. The Pearson chi-square test was applied to compare frequencies of qualitative variables, with a significance level of < 0.05.

For quantitative indicators, the arithmetic mean (M) and standard deviation (± SD) were used, and for qualitative indicators, percentages were reported. Statistical analysis was performed using IBM SPSS Statistics 22.

Results

Patients in groups O and P did not differ statistically significantly in terms of average age, body mass index (BMI), gender, nature, and frequency of complaints (Table 2).

Table 2. **Characteristics of patients in groups**

Indicator	Comparison group (n = 18)	Main group (n = 96)
Average age, years	50.3 ± 11.9	54.1 ± 10.1
Men Women	44.4 % 55.6 %	35.4 % 64.6 %
BMI, kg/m^2	26.5 ± 2.8	27.4 ± 2.7
Disease duration, months	58.9 ± 40.6	59.3 ± 53.7
Heartburn	9 (50.0 %)	51 (53.1 %)
Chest pain	10 (55.6 %)	40 (41.7 %)
Belching	6 (33.3 %)	41 (42.7 %)
Nausea	9 (50.0 %)	55 (57.3 %)
Hoarseness	12 (66.7 %)	45 (46.9 %)
Cough	7 (38.9 %)	24 (25.0 %)
Dysphagia	5 (27.8 %)	32 (33.3 %)
Hiccups	2 (11.1 %)	21 (21.9 %)
Odynophagia	3 (16.7 %)	13 (13.5 %)
Vomiting	3 (16.7 %)	19 (19.8 %)
Feeling of fullness after eating	5 (27.8 %)	36 (37.5 %)
Weight loss	3 (16.7 %)	25 (26.0 %)
Shortness of breath	5 (27.8 %)	28 (29.2 %)

Note. All $p > 0.05$.

One or more comorbidities were present in 124 (79.0 %) patients, including 14 (77.8 %) in group P and 78 (81.3 %) in group O ($p = 0.732$), (Table 3).

There were no statistically significant differences between the study groups regarding the nature and frequency of individual comorbidities (all $p > 0.05$).

No statistically significant differences were also found between the groups in instrumental study indicators (Table 4).

According to intraoperative data, the mean values of the area and width of the esophageal hiatus (EH) were greater in patients in the main group (Table 5).

In the main group, cruroplasty was performed in 25 (26.0 %) patients, cruroplasty reinforcement with a mesh implant in 71 (74.0 %); Nissen fundoplication was performed in 79 (82.3 %) patients, and Toupet fundoplication in 17 (17.7 %). In all cases, patients in group P underwent cruroplasty and Nissen fundoplication.

During the perioperative period, patients in the main group had a statistically significantly lower frequency of complications of grade I and

Table 3. **Nature and Frequency of comorbidities in groups**

Indicator	Comparison group (n = 18)	Main group (n = 96)
Ischemic heart disease	9 (50.0 %)	41 (42.7 %)
Heart failure	7 (38.9 %)	38 (39.6 %)
I degree	5 (71.4 %)	28 (73.7 %)
IIA degree	2 (18.6 %)	10 (26.3 %)
Heart rhythm disorders	4 (22.2 %)	34 (35.4 %)
Hypertension	9 (57.4 %)	50 (52.1 %)
I stage	3 (33.3 %)	10 (20.0 %)
II stage	6 (66.7 %)	40 (80.0 %)
Overweight	10 (55.6 %)	66 (68.8 %)
Obesity	2 (11.1 %)	10 (10.4 %)
Chronic bronchitis	7 (38.9 %)	38 (39.6 %)
Chronic obstructive pulmonary disease	2 (11.1 %)	14 (14.6 %)
A stage	1 (50.0 %)	8 (57.1 %)
B stage	1 (50.0 %)	6 (42.9 %)
Feeling of fullness after eating	5 (27.8 %)	36 (37.5 %)
Weight loss	3 (16.7 %)	25 (26.0 %)
Shortness of breath	5 (27.8 %)	28 (29.2 %)

Note. All p > 0.05.

Table 4. **Main Indicators of endoscopic and radiological studies**

Indicator	Comparison group (n = 18)	Main group (n = 96)
Endoscopic examination		
Esophagitis	13 (72.2 %)	58 (60.4 %)
Erosive esophagitis, stage*	9 (50.0 %)	53 (55.2 %)
A	3 (33.3 %)	6 (11.3 %)
B	3 (33.3 %)	21 (36.9 %)
C	2 (22.2 %)	20 (37.7 %)
D	1 (11.1 %)	6 (11.3 %)
Erosive gastritis	5 (27.8 %)	19 (19.8 %)
Duodenal ulcer	1 (5.6 %)	8 (8.3 %)
Radiological examination		
Reducibility		
Irreducible hernia	14 (77.8 %)	80 (83.3 %)
Partially reducible hernia	4 (22.2 %)	16 (16.7 %)
Hernia volume		
Cardiofundal	11 (61.1 %)	66 (68.8 %)
Subtotal	7 (38.9 %)	27 (28.1 %)
Total gastric	0	3 (1.6 %)
Hernia		
III type	17 (94.4 %)	87 (90.6 %)
IV type	1 (5.6 %)	9 (9.4 %)

Note. All p > 0.05.
* Los Angeles classification.

II according to the Clavien-Dindo classification (p = 0.009), with no grade III or IV complications observed in either group (Table 6).

On the first day after surgery, there was a significant difference between the groups in several studied indicators. The application of the ERAS protocol improved the perioperative period. Specifically, a statistically significant difference was found in the assessment of such important parameters as «feeling of hunger» and «feeling of weakness», which are factors that hinder the quick restoration of patients' quality of life after surgery and negatively impact the duration of hospital stay. In the main group, there was a higher proportion of patients with low scores on these indicators and a lower proportion with high scores (Fig. 1, 2). In this group, the average scores for «general weakness» and «feeling of hunger» were lower than in group P by 1.43 times (2.41 ± 0.67 and 3.44 ± 1.09 points) and 1.35 times (3.13 ± 1.3 and 4.22 ± 1.26 points), respectively (Table 7).

The patients in both groups also showed a statistically significant difference (p = 0.001) in the distribution of the «feeling of thirst» score. In the main group, there was a higher proportion of patients with lowэ scores and a lower proportion with high scores (Fig. 3), and the average score for this parameter was 1.34 times lower than in group P (1.51 ± 0.38 and 2.11 ± 0.90 points) (see Table 7).

Table 5. **Results of intraoperative measurement of EH parameters**

EH Parameters	Comparison group (n = 18)	Main group (n = 96)
Area, mm^2	86.8 ± 18.2 (53—161)	95.6 ± 23.2 (51—212)*
Width, mm	29.3 ± 3.3 (24—38)	31.1 ± 3.7 (24—43)*
Length, mm	54.8 ± 5.4 (46—65)	54.9 ± 7.0 (44—74)

Note. Minimum and maximum values are shown in parentheses.
* p < 0.05.

Table 6. **Distribution of patients in study groups by complication grade according to the Clavien-Dindo classification [3]**

Complication	Comparison group (n = 18)	Main group (n = 96)
Total	5 (27.8 %)	7 (7.3 %)*
I grade		
Myocardial ischemia episode (intraoperative)	1 (5.6 %)	1 (1.0 %)
Intraoperative episode of systolic blood pressure drop < 70 mm Hg	1 (5.6 %)	2 (2.0 %)
Bundle branch block	1 (5.6 %)	1 (1.0 %)
Paroxysm of atrial fibrillation	1 (5.6 %)	2 (2.0 %)
II grade		
Exudative pleuritis not requiring drainage	1 (5.6 %)	1 (1.0 %)

Note. * The difference in indicators is statistically significant (p = 0.009).

Table 7. **Comparative characteristics of survey results on the first postoperative day in the study groups**

Indicator	Comparison group (n = 18)	Main group (n = 96)
General weakness, points	3.44 ± 1.09	2.41 ± 0.67*
Feeling of hunger, points	4.22 ± 1.26	3.13 ± 1.30*
Feeling of thirst, points	2.11 ± 0.90	1.51 ± 0.38*
Gas passage	10 (55.6 %)	75 (78.1 %)**
Bowel movement	5 (27.8 %)	49 (51.0 %)
Abdominal distension	3 (16.7 %)	2 (2.1 %)**F
Nausea/vomiting	2 (11.1 %)	3 (3.1 %)

Note. * p = 0.001; ** p < 0.05. F Fisher's exact test.

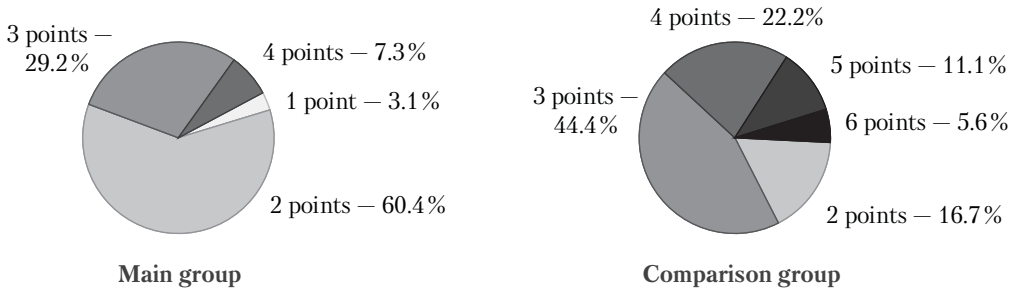

Figure 1. **Distribution of patients by general weakness score (p = 0.001)**

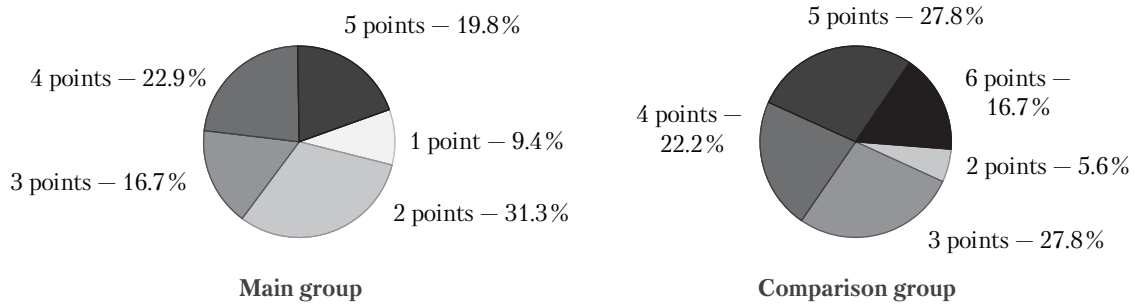

Figure 2. **Distribution of patients by hunger score (p = 0.001)**

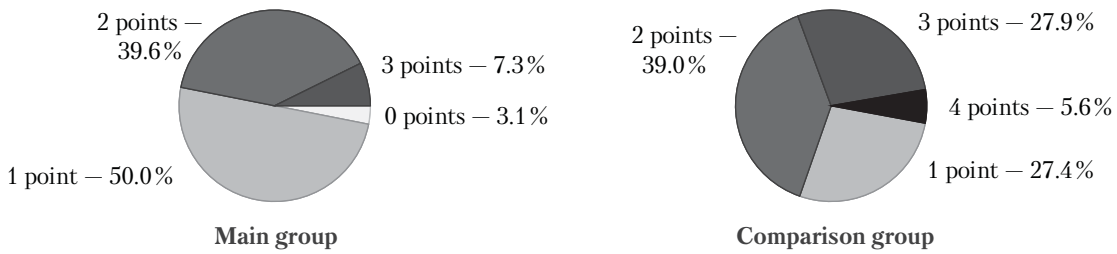

Figure 3. **Distribution of patients by thirst score (p = 0.001)**

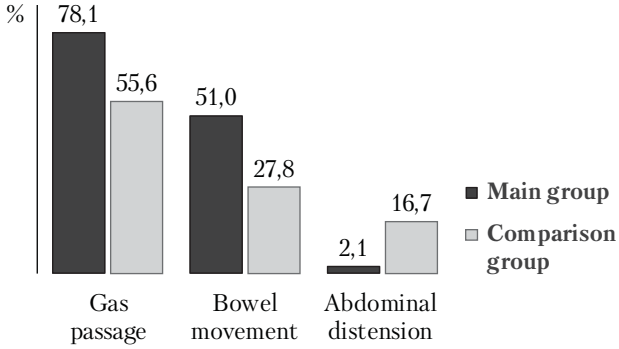

Figure 4. **Frequency of indicators characterizing bowel function recovery**

The use of the ERAS protocol in patients of the main group also had a positive impact on indicators characterizing the recovery of bowel function. In this group, on the first postoperative day, there was a higher proportion of patients who experienced gas passage — 78.1 % compared to 55.6 % ($p = 0.044$), bowel movement — 51.0 % compared to 27.8 % ($p = 0.070$), and a lower proportion of patients with abdominal distension — 2.1 % compared to 16.7 % ($p = 0.027$) (Fig. 4).

The positive effects of the ERAS protocol contributed to a reduction in the average length of hospital stay in the main group (1.72 ± 0.76 days) compared to group P (2.33 ± 0.91 days, $p = 0.003$).

Discussion Over the last decade, Enhanced Recovery After Surgery (ERAS) protocols have gained significant popularity due to their effectiveness in optimizing treatment outcomes [18, 20]. Currently, there are 24 core elements of patient care in the ERAS protocol, all supported by scientific evidence. In recent years, there has been a growing body of research dedicated to the application of ERAS protocol principles in the surgical treatment of abdominal diseases [1, 6, 14, 15, 19, 21], but there is a lack of data on their use in the surgical treatment of paraesophageal hernias (PEH).

The success of PEH repair depends on multiple factors (choice of access, use of mesh in cruroplasty, method of fundoplication, surgical technique). In addition to these surgeon-dependent factors, preoperative and postoperative care factors also significantly influence treatment outcomes. Patients with PEH often have excess body weight (in our study, the average body mass index in the main group was 27.4 ± 2.7 kg/m^2) and a high prevalence of chronic diseases: ischemic heart disease (42.7 %), cardiac arrhythmias (35.4 %), hypertension (52.1 %), chronic bronchitis (39.6 %), chronic obstructive pulmonary disease (14.6 %), erosive esophagitis (55.2 %), erosive gastritis (19.8 %), etc. This creates significant potential for improving outcomes by optimizing adverse factors in PEH patients prior to elective surgery.

Our study focused on assessing the effectiveness of ERAS strategy in the early postoperative period despite the fact that its philosophy aims not only at short-term goals, such as reducing hospital stay duration, but also at patient recovery in the long-term postoperative period.

To minimize the impact of open surgical access, only patients who underwent laparoscopic surgery were included in the study. On the first postoperative day, patients treated according to the ERAS protocol recorded significantly lower average scores for «general weakness», «feeling of hunger», and «feeling of thirst» (1.43, 1.35, and 1.34 times lower, respectively) compared to patients in the control group.

In addition, the use of the ERAS protocol had a positive impact on the recovery of bowel function: on the first postoperative day, the proportion of patients with gas passage was higher—78.1 % versus 55.6 %, bowel movement was observed in 51.0 % versus 27.8 %, and the proportion of patients with abdominal distension was lower—2.1 % versus 16.7 %.

These positive effects of the ERAS protocol contributed to a reduction in the average hospital stay to 1.72 ± 0.76 days compared to 2.33 ± 0.91 days in the control group.

Conclusions

The use of the ERAS protocol in patients undergoing laparoscopic surgery for type III—IV PEH demonstrates significant advantages in the early postoperative period, specifically with patients reporting significantly less «general weakness», «feeling of hunger», and «feeling of thirst» compared to the control group. Additionally, there were better indicators of bowel function recovery, as evidenced by a higher proportion of patients with gas passage and bowel movement and a significantly lower proportion of patients with abdominal distension.

The positive effects of the ERAS protocol contributed to a reduced average hospital stay.

The results obtained confirm the feasibility of implementing the ERAS protocol to improve postoperative recovery and reduce postoperative complications in patients with type III—IV PEH.

Declaration of interests

The authors declare no conflict of interest.

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technologies in the treatment of abdominal organ pathology, anterior abdominal wall, and morbid obesity using the 'fast track' methodology.» The authors received no additional financial support.

Authors contributions

Concept and design of the study — O. Y. Ioffe, T. A. Tarasov; data collection and analysis — O. P. Stetsenko, T. A. Tarasov; statistical analysis — L. Y. Markulan, T. A. Tarasov; manuscript writing— O. P. Stetsenko, T. A. Tarasov; critical review — O. Y. Ioffe, L. Y. Markulan, T. A. Tarasov.

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Ефективність стратегії ERAS у хворих з параезофагеальними грижами III—IV типу

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ERAS (Enhanced Recovery After Surgery)-протоколи довели ефективність у багатьох хірургічних спеціальностях, але її не було оцінено для хворих з параезофагеальними грижами (ПЕГ).

Мета — визначити ефективність стратегії ERAS у хворих із ПЕГ III—IV типу, яким проведено лапароскопічне втручання.

Матеріали та методи. Дослідження проведено на базах кафедри загальної хірургії № 2 Національного медичного університету імені О.О. Богомольця в 2017—2023 рр. із залученням 114 хворих, яким було виконано лапароскопічну герніопластику з приводу ПЕГ III—IV типу. У 96 хворих застосували стратегію ERAS (основна група — група О)), у 18 — не застосовували (група порівняння — група П)). Оцінку ефективності впровадження ERAS-протоколу проводили за середніми значеннями ліжко-дня, відчуттям голоду, спраги, загальної слабкості, депресії за 10-бальною візуальною аналоговою шкалою (0 балів — «не турбує», 10 балів — «сильно турбує»), частотою нудоти, блювання, здуття живота, відходження газів, наявністю випорожнення в першу добу після операції.

Результати. В групі О зареєстрували середні бали за показниками «загальна слабкість», «відчуття голоду» та «відчуття спраги», які були відповідно в 1,43, 1,35 та 1,34 разу меншими порівняно з такими в групі П. Застосування ERAS-протоколу позитивно вплинуло на відновлення функцій кишечника: в першу добу після операції частка пацієнтів із відходженням газів була більшою, ніж у групі П (78,1 та 55,6 % відповідно), а частка пацієнтів зі здуттям живота — меншою (2,1 і 16,7 %), випорожнення кишечника зафіксували в 51,0 та 27,8 % пацієнтів відповідно. Ці позитивні ефекти використання ERAS-протоколу сприяли скороченню середнього терміну перебування в стаціонарі до (1,72 ± 0,76) доби порівняно з (2,33 ± 0,91) доби у контрольній групі.

Висновки. Застосування ERAS-протоколу в пацієнтів, яким виконували лапароскопічні операції з приводу ПЕГ типу III—IV, продемонструвало значні переваги в ранній післяопераційний період. Пацієнти відзначили значно менше «загальної слабкості», «відчуття голоду» та «відчуття спраги» порівняно з контрольною групою. Зареєстровано кращі показники відновлення функцій кишечника, про що свідчила більша частка пацієнтів із відходженням газів і випорожненням кишечника та значно менша частка пацієнтів зі здуттям живота, а також зменшення середньої тривалості перебування в стаціонарі. Отримані результати підтверджують доцільність впровадження ERAS-протоколу для поліпшення відновлення після операцій та зменшення післяопераційних ускладнень у пацієнтів із ПЕГ типу III—IV.

Ключові слова: параезофагеальна грижа III—IV типу, хірургічне лікування, лапароскопічний доступ, ERAS-протокол, результати.

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