

# Comparative analysis of different methods of retraction of the left lobe of the liver during laparoscopic sleeve gastrectomy

O. O. Kalashnikov  \*1.A,B,C,D,E, O. Yu. Usenko  2.A,E,F, I. M. Todurov  1.C,E,F, S. V. Kosiukhno  1,B,E

<sup>1</sup>State Scientific Institution "Center for Innovative Medical Technologies of the National Academy of Sciences of Ukraine", Kyiv,

<sup>2</sup>State Institute "Shalimov's National Institute of Surgery and Transplantation" of the National Academy of Medical Sciences of Ukraine, Kyiv

A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of the article

## Ключові слова:

ожиріння, лапароскопічна рукавна резекція шлунка, ретракція печінки, печінкова дисфункція, пошкодження печінки.

## Key words:

obesity, gastrectomy, laparoscopy, liver retraction, liver dysfunction, liver injury.

Надійшла до редакції /  
Received: 31.05.2023

Після доопрацювання /  
Revised: 22.06.2023

Схвалено до друку /  
Accepted: 28.06.2023

**Конфлікт інтересів:**  
відсутній.

**Conflicts of interest:**  
authors have no conflict of interest to declare.

**\*E-mail:**  
kalashnikov.cimt@gmail.com

The global obesity epidemic has led to the increasing popularity of bariatric surgeries. Laparoscopic sleeve gastrectomy is currently the most popular bariatric procedure for obesity. Retracting of the left liver lobe during laparoscopic sleeve gastrectomy is important for achieving an optimal surgical field.

**Aim.** The aim of our study was to evaluate the results of using different methods of retraction of the left liver lobe during laparoscopic sleeve gastrectomy in patients with morbid obesity.

**Materials and methods.** The 86 patients who underwent laparoscopic sleeve gastrectomy were divided into three groups based on the liver retraction method used: group 1 (ENDO RETRACT™ II), group 2 (Nathanson) and group 3 (Clickline Surgical Sponge Holder). All groups were evaluated in terms of demographic characteristics; liver function tests just before surgery and on the 1<sup>st</sup> and 2<sup>nd</sup> postoperative day (POD); developing complications and length of hospital stay.

**Results.** The groups did not differ significantly in terms of demographic characteristics ( $p > 0.05$ ). The Nathanson liver retractor (group 2) caused a significant rise in ALT and AST at POD 1 and POD 2 compared with group 1 and 3 ( $p < 0.05$ ). The ENDO RETRACT™ II liver retractor (group 1) caused a higher incidence of liver injury than other groups. It led to statistical significance prolonged total operation time ( $p = 0.003$ ), increased blood loss ( $p = 0.002$ ) and prolonged postoperative hospital stay ( $p = 0.001$ ) compared with other groups.

**Conclusions.** The technique of left lobe retraction during laparoscopic sleeve gastrectomy using Clickline Surgical Sponge Holder is safe and effective. The use of this technique causes significantly less measurable liver damage and does not lead to an increase in the level of liver enzymes.

**Modern medical technology. 2023;(3):5-11**

## Порівняльний аналіз використання різних методик ретракції лівої долі печінки під час лапароскопічної рукавної резекції шлунка

O. O. Калашніков, О. Ю. Усенко, І. М. Тодуров, С. В. Косюхно

Глобальна епідемія ожиріння призвела до збільшення популярності бариатричних операцій. Лапароскопічна рукавна резекція шлунка – найпопулярніша бариатрична операція під час лікування ожиріння. Ретракція лівої долі печінки під час лапароскопічної рукавної резекції шлунка є однією з ключових складових успішного виконання операції.

**Мета роботи** – оцінити результати використання різних методик ретракції лівої частки печінки під час лапароскопічної рукавної резекції шлунка у хворих на морбідне ожиріння.

**Матеріали та методи.** Лапароскопічну рукавну резекцію шлунка виконали 86 пацієнтам, яких поділили на три групи залежно від використаної методики ретракції лівої долі печінки: група 1 – ENDO RETRACT™ II, група 2 – Nathanson, група 3 – Clickline Surgical Sponge Holder. Групи обстежених оцінювали за демографічними характеристиками, визначали рівні печінкових ферментів безпосередньо перед операцією, на 1 та 2 післяопераційні доби, фіксували кількість епізодів ускладнень і тривалість перебування в стаціонарі.

**Результати.** Групи зіставні за демографічними характеристиками ( $p > 0,05$ ). У другій групі пацієнтів у першу та другу післяопераційні доби зафіксовано статистично значущу елевачію печінкових ферментів (АлАт та АсАт) порівняно з доопераційними значеннями. Визначили також статистично значущу різницю за медіанами печінкових ферментів у першу та другу післяопераційні доби порівняно з відповідними показниками в першій і третій групах ( $p < 0,05$ ). Найбільшу кількість випадків пошкодження паренхіми печінки встановили у групі 1, де використовували ENDO RETRACT™ II.

Це спричинило статистично значущу пролонгацію загальної тривалості операції ( $p = 0,003$ ), збільшення крововтрати ( $p = 0,002$ ) та триваліше перебування в стаціонарі ( $p = 0,001$ ) порівняно з іншими групами.

**Висновки.** Техніка ретракції лівої долі печінки під час лапароскопічної рукавної резекції печінки за допомогою губкотримача Clickline Surgical Sponge Holder є безпечною та ефективною. Використання цієї методики сприяє зменшенню випадків пошкоджень паренхіми печінки і не призводить до підвищення рівня печінкових ферментів.

**Сучасні медичні технології. 2023. № 3(58). С. 5-11**

According to the World Health Organization, obesity has long been an epidemic worldwide, affecting people regardless to age, gender, race, or geographic location. Being overweight is one of the key factors in the development of insulin resistance, and subsequently the development of diabetes mellitus. In addition, obesity, associated with the metabolic syndrome, worsens the course of diseases of the musculoskeletal system, cardiovascular, respiratory, digestive and reproductive systems [1].

A number of meta-analyses and randomized clinical trials have shown the benefits of bariatric surgery over conservative treatments for obesity and related metabolic disorders [2].

Bariatric surgery has made a dramatic breakthrough over the past decade, and its popularity is only growing every year. This is confirmed by the increasing number of operations on all continents. Thus, if 146 thousand of them were performed worldwide in 2003, then their number reached more than 685 thousand in 2016. Among the wide range of bariatric surgeries, laparoscopic sleeve gastrectomy (LSG) has confidently taken the leading position as the most performed bariatric surgery in the world [3].

A large number of publications demonstrate its effectiveness and safety in the early and late postoperative period, sustained and long-term reduction of overweight and compensation for concomitant metabolic disorders, primarily type 2 diabetes [2].

Due to the development of medical technology and the improvement of surgical skills, minimally invasive approaches have become a higher priority in almost all areas of surgery, including bariatric surgery [3]. During laparoscopic gastric surgery, adequate retraction of the left lobe of the liver is one of the key points of its successful performance. An enlarged left lobe of the liver, usually due to non-alcoholic fatty liver disease (NAFLD), occurs in 90 % of patients with morbid obesity [4]. It, in turn, significantly interferes with LSG and can cause intra-abdominal bleeding due to liver injury. That is why the choice of hepatic retractor can play a key role in the successful performance of LSG. There are few publications in the literature that analyze the effectiveness of various methods of left lobe retraction during LSG and assess their safety for the patient.

## Aim

The aim of our study was to evaluate the results of using different methods of retraction of the left lobe of the liver during laparoscopic sleeve gastrectomy in patients with morbid obesity.

## Materials and methods

This retrospective study was based on an analysis of the treatment outcomes of 86 patients who underwent LSG.

The patients involved in this study were divided into 3 groups. The first group included 27 patients in whom the ENDO

RETRACT™ II by Auto Suture was used for retraction of the left lobe of the liver. The second group included 27 patients in whom the Nathanson retraction system by Karl Storz was used and the third group included 32 patients in whom the Clickline Surgical Sponge Holder Set for Atraumatic Tissue by Karl Storz for left liver lobe retraction was used. The methods of left liver retraction are shown in Fig. 1.

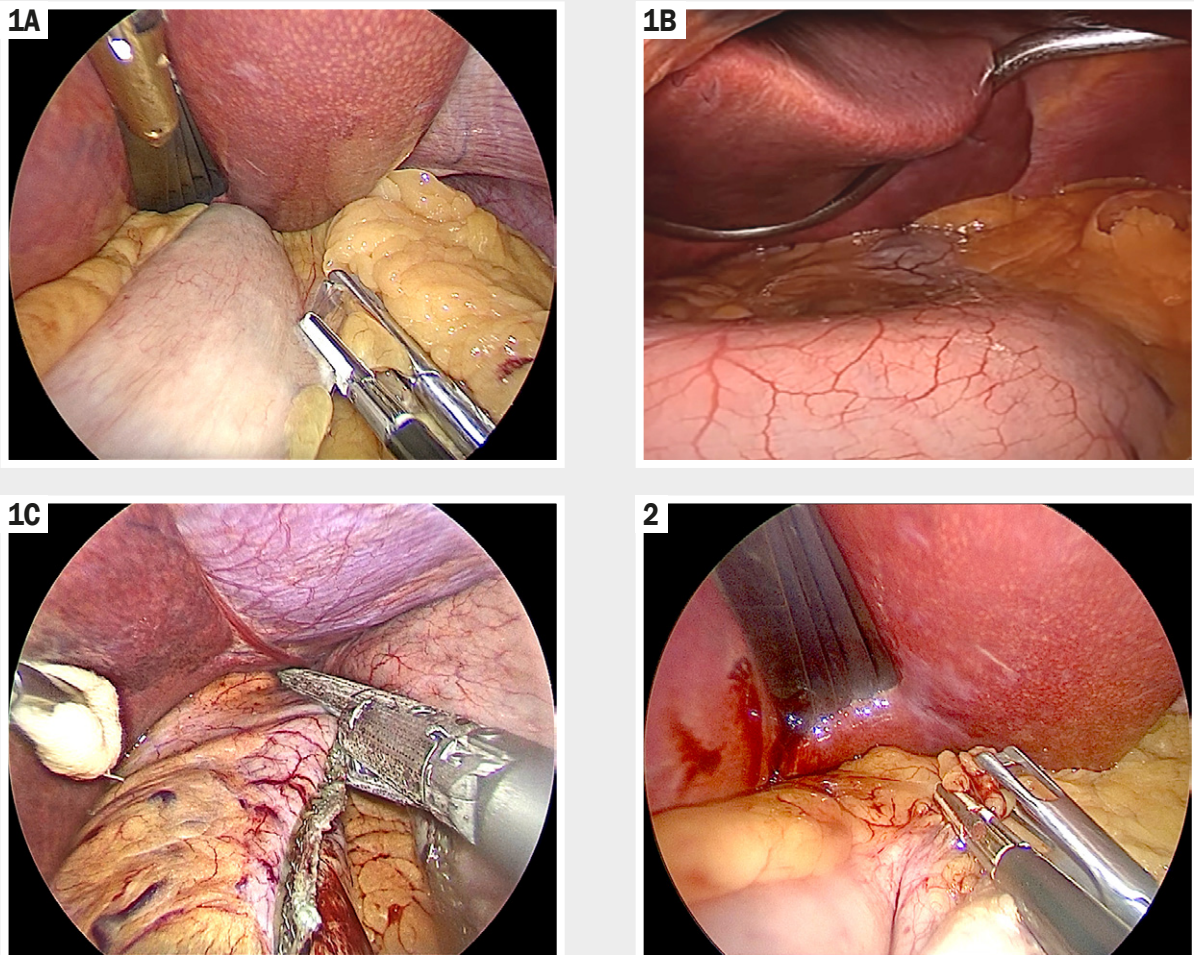
Besides age and sex, the following anthropometric parameters were assessed: body weight (kg), body mass index (BMI) ( $\text{kg}/\text{m}^2$ ) and excess body weight (kg).

The laboratory parameters analyzed in this study were alanine aminotransferase (ALT, IU/l), aspartate aminotransferase (AST, IU/l), and total bilirubin (mg/dl) preoperatively, on the first and second day after surgery.

The results of surgical treatment were evaluated according to the following criteria: total operation time, intraoperative liver injury, blood loss, and hospital stay after surgery.

**The technique of LSG surgery.** The traditional scheme of trocar placement was used to perform the operation. After the formation of the pneumoperitoneum, the first step was to mobilize the stomach. Using LigaSure electro-surgical instruments on a 12 mm (36 Fr) calibration tube, the great curvature and the bottom of the stomach were mobilized with electrical ligation of the gastric branches of the right and left gastroesophageal vessels, short vessels and the posterior gastric artery with mandatory crossing of the gastroduodenal ligament and visualization of the left crus of the diaphragm. The latter is a criterion for the adequacy of mobilization in the gastric fundus. The initial level of mobilization of the large curvature was at a distance of 4 cm from the pylorus. After that, the calibration tube was passed into the duodenum and its position along the small curvature was ensured. Using linear suturing devices Echelon Flex (Ethicon) or Endo GIA (Medtronic), a staged vertical resection of the stomach was performed on a 12 mm (36 Fr) calibration tube from the level of 4 cm from the pylorus (initial mobilization point) to the angle of His, ensuring a gastric tube width of up to 2 cm and a controlled retreat of the staple suture line from the esophagogastric junction by 1 cm. The resection stage of the operation was performed with moderate lateral traction of the large curvature of the stomach by the assistant strictly behind the line of its mobilization. The stapler suture line was peritonized on the calibration tube with a continuous sero-serous suture. During the surgery, each patient underwent a gastric tube leak test with methylene blue solution through a nasogastric tube and the operation was completed by abdominal drainage.

Statistical data processing was performed using the methods of variation and descriptive statistics with the help of the statistical analysis package SPSS Statistics: An IBM Company, version 23. Before starting the data analysis, all indicators were checked for normality of distribution using the Shapiro–Wilcoxon test and for equality of variances using the Levene's test.



**Fig. 1.** Intraoperative view of the methods of left liver retraction. **A:** ENDO RETRACT™ II; **B:** Nathanson retraction system; **C:** Clickline Surgical Sponge Holder Set for Atraumatic Tissue.

**Fig. 2.** Intraoperative view of the left lobe of the liver injury with the ENDO RETRACT™ II.

Descriptive statistics such as mean (M) and standard deviation (SD) (for normal distribution) or median (Me) and interquartile range [IQR] (for non-normal distribution) were used in the study. Statistically significant differences in relative indicators were assessed using the Pearson's  $\chi^2$ -square criterion with the Yates correction. To evaluate statistically significant differences in the mean values of quantitative traits between the three groups, which are subject to the law of normal distribution, the One-way ANOVA test was used. To compare the mean values between the three dependent groups, in the case of normal distribution, the Friedman test was used. In order to determine the difference in mean values between groups, a posteriori pairwise comparison was performed using the Wilcoxon (W) test with Bonferroni correction. The Kruskal–Wallis test was used to compare the mean values between three independent groups in the case of non-normal distribution. To assess the differences between groups, a posteriori pairwise comparison was performed using the Mann–Whitney (U) test with Bonferroni correction. Differences in the results were considered statistically significant at  $p < 0.05$ , which provides a 95 % proba-

bility level when applying the criterion  $\chi^2$  Pearson's square with the Yates correction. When assessing the differences between the three groups, the difference in the results was considered statistically significant, taking into account the Bonferroni correction,  $p = 0.016$ .

## Results

The comparison groups were homogeneous in terms of age, gender, and anthropometric parameters ( $p > 0.05$ ). The main characteristics of patients by group are presented in *Table 1*.

Despite the fact that the technique of performing LSG was the same in all patients, the difference in the average total operation time between the groups reached statistical significance ( $p = 0.003$ ).

The longest surgical intervention time was recorded in the first group of patients, in which ENDO RETRACT™ II was used for retraction of the left lobe of liver, the average value was  $134.1 \pm 10.4$  minutes. The main criteria for evaluating the results of surgical treatment are presented in *Table 2*.

**Table 1.** Patient characteristics (demographic characteristics), M ± SD / Me [IQR]

Parameter, units of measurement	Group 1 (ENDO RETRACT™ II), n = 27	Group 2 (Nathanson liver retractor), n = 27	Group 3 (Clickline Surgical Sponge Holder), n = 32	p-value
Age, years	37.9 ± 10.8	44.1 ± 12.3	44.5 ± 11.6	0.066*
Sex, Male / Female	15 M / 12 F	13 M / 14 F	19 M / 13 F	0.68 <sup>§</sup>
Weight, kg	130.0 [125.0; 140.0]	127.0 [114.0; 147.0]	143.7 [117.0; 163.0]	0.181 <sup>#</sup>
BMI, kg/m <sup>2</sup>	43.4 [41.0; 50.0]	44.6 [38.9; 48.6]	46.1 [41.1; 51.9]	0.119 <sup>#</sup>
Excess body weight, kg	62.0 [58.0; 74.0]	65.3 [51.0; 76.0]	74.8 [54.7; 89.8]	0.113 <sup>#</sup>

\*: One-way ANOVA test; <sup>§</sup>: Pearson's  $\chi^2$ -square test; <sup>#</sup>: Kruskal–Wallis test.

**Table 2.** Main intraoperative parameters and length of hospital stay depending on the method of left lobe retraction, M ± SD / Me [IQR]

Parameter, units of measurement	Group 1 (ENDO RETRACT™ II), n = 27	Group 2 (Nathanson liver retractor), n = 27	Group 3 (Clickline Surgical Sponge Holder), n = 32	p-value
Total operation time, min	134.1 ± 10.4	116.7 ± 25.6	115.3 ± 24.9	0.003*
Liver injury, n (%)	11 (40.7 %)	1 (3.7 %)	0 (0.0 %)	0.0001 <sup>§</sup>
Blood loss, ml	229.6 ± 99.2	159.3 ± 62.1	175.0 ± 55.4	0.002*
Postoperative hospital stay, days	7 [7; 8]	5 [4; 7]	6 [5; 7]	0.001 <sup>#</sup>

\*: One-way ANOVA test; <sup>§</sup>: Pearson's  $\chi^2$ -square test; <sup>#</sup>: Kruskal–Wallis test.

**Table 3.** Laboratory data of patients, Me [IQR]

Parameter, units of measurement	Group 1 (ENDO RETRACT™ II), n = 27	Group 2 (Nathanson liver retractor), n = 27	Group 3 (Clickline Surgical Sponge Holder), n = 32	p-value	
ALT, IU/l	Preoperative	24.2 [21.3; 31.1]	31.2 [20.9; 41.5]	30.8 [26.1; 42.6]	0.083*
	POD 1	28.1 [21.3; 37.4]	49.2 [34.9; 61.2]	31.6 [22.5; 38.4]	0.001*
	POD 2	29.3 [21.1; 37.0]	52.4 [41.5; 66.7]	32.5 [28.2; 37.8]	0.001*
	p-value	0.87 <sup>#</sup>	0.0001 <sup>#</sup>	0.86 <sup>#</sup>	
AST, IU/l	Preoperative	27.3 [21.6; 31.2]	26.7 [16.4; 30.9]	29.7 [22.2; 37.6]	0.26*
	POD 1	26.4 [21.1; 32.4]	39.7 [28.1; 49.8]	25.6 [21.0; 29.3]	0.001*
	POD 2	31.1 [21.4; 35.2]	42.3 [31.2; 54.3]	25.8 [17.5; 28.7]	0.001*
	p-value	0.29 <sup>#</sup>	0.0001 <sup>#</sup>	0.49 <sup>#</sup>	
Total bilirubin, mg/dl	Preoperative	15.1 [11.2; 17.4]	13.5 [10.8; 15.8]	13.5 [11.9; 17.0]	0.49*
	POD 1	14.4 [12.1; 16.3]	15.4 [11.6; 16.7]	15.6 [11.8; 17.7]	0.39*
	POD 2	16.2 [12.1; 17.2]	13.4 [11.2; 16.7]	14.8 [11.2; 16.5]	0.24*
	p-value	0.48 <sup>#</sup>	0.3 <sup>#</sup>	0.44 <sup>#</sup>	

POD: postoperative day; <sup>#</sup>: Friedman test; \*: Kruskal–Wallis test.

The total number of intraoperative injuries of the left lobe of the liver was 12 cases and the highest number of injuries was recorded in patients of the first group in whom the ENDO RETRACT™ II was used ( $\chi^2 = 23.69$ ;  $p = 0.0001$ ) (Fig. 2).

In all cases, the injury to the left lobe of the liver required hemostasis by bipolar coagulation. This, in turn, led to the prolongation of total operation time in the first group compared to the average value in the second and third groups ( $p = 0.003$ ).

The average blood loss in the first group was  $229.6 \pm 99.2$  ml, in the second –  $159.3 \pm 62.1$  ml and  $175.0 \pm 55.4$  ml in the third, respectively. In all groups, this indicator was clinically insignificant, but the difference between the groups was statistically significant ( $p = 0.002$ ).

After a more detailed analysis of the differences between the groups by a posteriori pairwise comparison using the Bonferroni test, it was found that a statistically significant difference was re-

corded between the mean values of the volume of intraoperative blood loss of the first and second groups and the first and third groups ( $p < 0.05$ ). At the same time, there was no statistically significant difference in the same indicator between the second and third groups ( $p > 0.05$ ).

The tactics of patient management in the postoperative period were the same. Enteral nutrition was started from the first postoperative day, the volume of infusion therapy, antibiotic and thromboprophylaxis was performed according to the protocol of enhanced recovery after LSG.

All patients involved in the study did not receive hepatotoxic preparations.

To assess liver function, the level of bilirubin and liver enzymes (ALT and AST) was analyzed, the median and interquartile range by group are presented in *Table 3*.

Before the operation, the median hepatic parameters were within normal limits and did not differ statistically between the groups ( $p > 0.05$ ).

In the second group of patients who underwent retraction of the left lobe of the liver using the Nathanson retraction system (*Fig. 2*), a statistically significant increase in liver enzymes (ALT and AST) was recorded on the first and second postoperative days compared with preoperative values. There was also a statistically significant difference between the median liver enzymes on the first and second postoperative day compared with similar values in the first and third groups ( $p < 0.05$ ). At the same time, bilirubin was within normal limits in all groups and did not differ statistically significantly throughout the postoperative period ( $p > 0.05$ ).

There were no clinically significant symptoms of liver enzyme elevation in the postoperative period.

There were no reoperations or deaths among the patients included in the study. However, the median number of days of hospitalization in the first group was statistically significantly higher compared to the medians of the second and third groups ( $p = 0.001$ ).

At the control examination, 1 month after surgery, all patients in the second group had normalized liver enzymes and returned to preoperative levels.

## Discussion

The tendency of the last decades shows that the number of people suffering from obesity is steadily increasing from year to year. Thus, according to the latest data from the World Health Organization, in 2016, more than 1.9 billion adults (aged 18 years and older) were overweight, of whom more than 650 million suffered from obesity [1].

Compared to non-surgical methods of treating obesity, bariatric surgery results in greater weight loss and compensation for metabolic disorders associated with obesity, primarily type 2 diabetes mellitus [2].

For instance, in one of the fundamental studies, a group of authors led by Schauer P.R. compared the results of medical treatment and bariatric surgery in patients with diabetes mellitus during a 5-year follow-up. This prospective randomized controlled trial included 150 patients. Based on the results, the authors concluded that patients after bariatric surgery had better glycemic control,

even in patients with a BMI of 27–34 kg/m<sup>2</sup>, which in turn led to a reduction in the use of diabetes and cardiovascular medications. There was also a significant reduction in excess body weight, improvement in lipid profile and quality of life indicators compared to the group of patients who received medical treatment [5].

Since 2014, the most common bariatric intervention has been LSG. Thus, if in 2011 the percentage of all bariatric operations performed was only 17.8 %, in 2018 this figure was 61.4 % [3].

After the introduction of enhanced recovery protocols into clinical practice, which was first described by N. Kehlet in 1997 in planned colorectal surgery [6], the tactics of managing patients in the perioperative period have changed dramatically in all areas of gastrointestinal surgery, including major surgery on the esophagus and stomach [7,8].

Modern views on the management of patients in abdominal surgery have not left patients after bariatric surgery untouched. Thus, a group of authors led by E. Stenberg developed guidelines for the perioperative management of patients after bariatric surgery, taking into account the recommendations of the society for the study and implementation of rapid recovery protocols [9].

Laparoscopic access is one of the key points of enhanced recovery protocols [9]. With the development of endoscopic medical equipment, laparoscopic instruments, the creation of modern energy platforms for vascular ligation, and the development of suturing devices, the percentage of laparoscopic surgeries is increasing from year to year. For example, according to the latest data from the registry of the International Federation for the Surgical Treatment of Obesity, 99 % of bariatric surgeries were performed using laparoscopic access [10].

During laparoscopic surgery of the upper gastrointestinal tract, retraction of the left lobe of the liver is a key component of the success of the operation. The retractor should be easy to use and provide adequate visualization for safe operation in the area of the gastroesophageal junction, Gyss angle, small and large gastric curvature.

In obese patients, abnormal lipid deposition in the liver leads to its enlargement and the development of NAFLD [4]. An enlarged left lobe of the liver prevents access to the esophagogastric junction, while the liver parenchyma is relatively friable and sensitive to injury with a risk of bleeding. According to Schwartz M. L. and co-authors, it was found that hepatomegaly was one of the key factors in conversion during laparoscopic Roux-en-Y Gastric Bypass [11].

Preoperative preparation of patients before bariatric surgery is of great clinical importance, which can significantly affect the course of the early postoperative period. For example, a 2-week preoperative low-calorie, high-protein, low-carbohydrate diet can reduce the volume of the left lobe of the liver and reduce the thickness of the anterior abdominal wall, thereby improving visualization during surgery, shortening the duration of the intervention itself, and reducing the incidence of postoperative complications [12].

With the development of the medical industry, various variants of hepatic retractors have been proposed. Thus, A. Vargas-Palacios and co-authors in their systematic review analyzed the results of using 10 different methods of liver retraction during laparoscopic surgery. This paper describes, although rare, some very serious complications that can occur after retraction of the

left lobe of the liver during laparoscopic surgery: transient hepatic dysfunction (manifested by elevated liver enzymes), traumatic liver parenchyma rupture, and delayed liver necrosis. Although, no severe complications, including those requiring conversion, have been reported in any of the publications. However, each technique has its advantages and disadvantages [13].

Speaking of the retraction of the left lobe of the liver in single-port surgery, the latest methods of stitching or tying the liver parenchyma to the anterior abdominal wall with silk material are of great importance, which in turn minimizes the number of working trocars and can lead to a reduction in the time of surgery. These techniques do not lead to significant pathophysiological disorders in the liver parenchyma, as they do not have strong traction and pressure effects on the parenchyma. However, these techniques are difficult and dangerous to use in patients with NAFLD. Therefore, their use is more justified in patients with a nonenlarged left lobe of the liver and class 1–2 obesity. Thus, according to a literature review published by P. Lainas and co-authors in 2020, the average BMI in patients who underwent single-port sleeve liver resection was up to 40 kg/m<sup>2</sup> [14].

After the description of the technical aspects and advantages of using the Nathanson retraction system by Bann S. and colleagues in 2005, this technique gained popularity and became widely used in various laparoscopic surgical interventions on the gastrointestinal tract [15]. During surgical interventions in the upper gastrointestinal tract, this technique makes it possible to cover a sufficiently large area of the left lobe of the liver and, with little effort, to achieve adequate retraction of the left lobe and visualize the entire left subhepatic space, thereby increasing the field of surgery. However, the Nathanson retraction system is one of the most traumatic methods of left lobe retraction. Due to the structure of the system itself, which is fixed to the operating table, there is a constant local pressure on the liver parenchyma, which can lead to an elevation of hepatic cytolysis markers in the postoperative period.

Thus, Goel R. and co-authors conducted a randomized clinical trial comparing the results of using different hepatic retractors in patients after laparoscopic Roux-en-Y Gastric Bypass. In the group of patients in whom the Nathanson retraction system was used during surgery, more cases of hepatic dysfunction, manifested by an increase in liver enzymes, were statistically significantly recorded [16].

We obtained similar results in our study. In the group of patients in whom the Nathanson retraction system was used for left lobe retraction, a statistically significant elevation of liver enzymes was observed on the first and second day after surgery, without other significant clinical deviations from the normal course of the postoperative period.

One of the possible causes of liver enzyme elevation (transient hepatic dysfunction) was the hypothesis of a negative effect of pneumoperitoneum on the blood supply to the liver during surgery. Thus, T. Etoh and co-authors analyzed episodes of transient hepatic dysfunction in patients in the postoperative period after open and laparoscopic gastrectomy. Based on the results obtained, the authors concluded that the formation of pneumoperitoneum is one of the risk factors and the cause of transient hepatic dysfunction in the postoperative period [17].

At the same time, a group of authors led by R. Meiehenrich refuted the effect of intra-abdominal pressure during laparoscopic surgery on reducing blood flow in the liver. Through the use of intraoperative transesophageal echocardiography, the authors demonstrated the opposite effect with an increase in blood flow in the liver during laparoscopic surgery [18].

However, most authors agree that it is the local mechanical compression factor that causes transient elevation of liver enzymes. Thus, J. C. Lohlun and co-authors in their study, published in 2004, noted an increase in liver enzymes in the postoperative period in patients after Roux-en-Y Gastric Bypass from the open access. One of the key objectives was to analyze the relationship between changes in liver enzymes and the time of left lobe retraction during surgery. The results obtained allowed the authors to conclude that the elevation of liver enzymes in the postoperative period directly correlated with the duration of left lobe retraction during Roux-en-Y Gastric Bypass [19].

Despite the clinically insignificant elevation of hepatic enzymes after prolonged compression by the liver retractor, structural changes may occur in the parenchyma, which may cause significant problems in the future. Thus, Nabil A. Yassa and co-authors in their study analyzed changes in the liver structure using computed tomography (CT) after using the Nathanson retraction system during gastric surgery. The authors found that the uneven enhancement of the liver parenchyma pattern was atypical for infarction or focal fatty infiltration. The location of the lesions corresponded to the placement of the retractor during surgery, and the lesions were stable on follow-up CT scans. The appearance on CT was secondary to contusion or focal necrosis of the liver due to compression of the retractor on the left lobe of the liver [20].

Due to the peculiarities of the structure of some hepatic retractors, traumatic rupture of the Glisson-Lehmann capsule and liver parenchyma may occur intraoperatively, especially in patients with an enlarged left lobe of the liver with NAFLD. Thus, in our study, 12 patients had intraoperative trauma to the left lobe of the liver, of whom 11 patients used ENDO RETRACT™ II for left lobe retraction.

Even in the folded position, due to its rather sharp edges, it remains quite traumatic. In all cases, the injury to the left lobe of the liver required hemostasis by bipolar coagulation. This, in turn, led to a statistically significant prolongation of surgical intervention, increased blood loss, and longer hospital stay compared to other methods of left lobe retraction ( $p < 0.05$ ).

In our study, the best results were obtained in the group of patients in whom Clickline Surgical Sponge Holder was used for left liver retraction. The use of this technique allows for adequate visualization of the left subhepatic space, thereby increasing the field of surgery and providing satisfactory visualization for safe work in the area of the gastroesophageal junction, Gyss angle, small and large gastric curvature. Thanks to the dosed retraction of the left lobe of the liver with the necessary time management, we managed to avoid mechanical injuries to the liver parenchyma, which in turn did not lead to transient elevations in transaminase levels in the postoperative period.

## Conclusions

When performing LSG in patients with morbid obesity, the choice of a hepatic retractor is one of the key positions for a successful course of the perioperative period. The use of ENDO RETRACT™ II by Auto Suture statistically significantly increases the total operation time, blood loss, and hospital stay. In patients in whom the Nathanson retraction system by Karl Storz was used during LSG, a statistically significant transient elevation of liver enzymes was observed in the postoperative period.

The technique of left lobe retraction during LSG using Click-line Surgical Sponge Holder is safe and effective. This technique avoids complications in the perioperative period, which in turn leads to improved treatment outcomes in patients with morbid obesity.

### Information about the authors:

Kalashnikov O. O., MD, PhD, Senior Researcher of the Department of Minimally Invasive Surgery, SSI "Center for Innovative Medical Technologies of the National Academy of Sciences of Ukraine", Kyiv.

ORCID ID: 0000-0002-8224-8039

Usenko O. Yu., MD, PhD, DSc, Professor, Director of State Institute "Shalimov's National Institute of Surgery and Transplantation" of the National Academy of Medical Sciences of Ukraine, Kyiv, Academician of the National Academy of Medical Sciences of Ukraine.

ORCID ID: 0000-0001-8074-1666

Todurov I. M., MD, PhD, DSc, Professor, Head of the Department of Endocrine and Metabolic Surgery, Director of SSI "Center for Innovative Medical Technologies of the National Academy of Sciences of Ukraine", Kyiv.

ORCID ID: 0000-0001-6170-6056

Kosiukhno S. V., MD, PhD, Head of the Department of Minimally Invasive Surgery, SSI "Center for Innovative Medical Technologies of the National Academy of Sciences of Ukraine", Kyiv.

ORCID ID: 0000-0002-2950-9279

### Відомості про авторів:

Калашніков О. О., канд. мед. наук, провідний науковий співробітник відділу малоінвазивної хірургії, ДНУ «Центр інноваційних медичних технологій НАН України», м. Київ.  
Усенко О. Ю., д-р мед. наук, професор, директор ДУ «Національний інститут хірургії та трансплантології імені О. О. Шалімова» Національної академії медичних наук України, м. Київ, академік Національної академії медичних наук України.  
Тодуров І. М., д-р мед. наук, професор, зав. відділу ендокринної та метаболічної хірургії, директор ДНУ «Центр інноваційних медичних технологій НАН України», м. Київ.

Косюхно С. В., канд. мед. наук, зав. відділу малоінвазивної хірургії, ДНУ «Центр інноваційних медичних технологій НАН України», м. Київ.

### References

- [1] The Lancet Gastroenterology Hepatology. Obesity: another ongoing pandemic. *Lancet Gastroenterol Hepatol.* 2021;6(6):411. doi: 10.1016/S2468-1253(21)00143-6.
- [2] Järholm K, Janson A, Peltonen M, Neovius M, Gronowitz E, Engström M, et al. Metabolic and bariatric surgery versus intensive non-surgical treatment for adolescents with severe obesity (AMOS2): a multicentre, randomised, controlled trial in Sweden. *Lancet Child Adolesc Health.* 2023;7(4):249-60. doi: 10.1016/S2352-4642(22)00373-X.
- [3] Angrisani L, Santonicola A, Iovino P, Vitiello A, Higa K, Himpens J, et al. IFSO Worldwide Survey 2016: Primary, Endoluminal, and Revisional Procedures. *Obes Surg.* 2018;28(12):3783-94. doi: 10.1007/s11695-018-3450-2.
- [4] Polyzos SA, Kountouras J, Mantzoros CS. Obesity and nonalcoholic fatty liver disease: From pathophysiology to therapeutics. *Metabolism.* 2019;92:82-97. doi: 10.1016/j.metabol.2018.11.014.
- [5] Schauer PR, Bhatt DL, Kirwan JP, Wolski K, Aminian A, Brethauer SA, et al. Bariatric Surgery versus Intensive Medical Therapy for Diabetes - 5-Year Outcomes. *N Engl J Med.* 2017;376(7):641-51. doi: 10.1056/NEJMoa1600869.
- [6] Kehlet H. Multimodal approach to control postoperative pathophysiology and rehabilitation. *Br J Anaesth.* 1997;78:606-17. doi: 10.1093/bja/78.5.606.
- [7] Lee Y, Yu J, Doumouras AG, Li J, Hong D. Enhanced recovery after surgery (ERAS) versus standard recovery for elective gastric cancer surgery: A meta-analysis of randomized controlled trials. *Surg Oncol.* 2020;32:75-87. doi: 10.1016/j.suronc.2019.11.004.
- [8] Kalashnikov OO, Usenko OYu, Todurov IM, Plehutsa OI. Gastric decompression in patients after laparoscopy sleeve gastrectomy. *Fiziol Zh.* 2023;69(2):44-51. doi: 10.15407/fz69.02.044.
- [9] Stenberg E, Dos Reis Falcão LF, O'Kane M, Liem R, Pournaras DJ, Salminen P, et al. Guidelines for Perioperative Care in Bariatric Surgery: Enhanced Recovery After Surgery (ERAS) Society Recommendations: A 2021 Update. *World J Surg.* 2022;46(4):729-51. doi: 10.1007/s00268-021-06394-9.
- [10] The International Federation for the Surgery of Obesity and Metabolic Disorders. 6th IFSO Global Registry Report 2021. IFSO 2021. <https://www.ifso.com/pdf/ifso-6th-registry-report-2021.pdf>.
- [11] Schwartz ML, Drew RL, Chazin-Caldie M. Laparoscopic Roux-en-Y gastric bypass: preoperative determinants of prolonged operative times, conversion to open gastric bypasses, and postoperative complications. *Obes Surg.* 2003;13(5):734-8. doi: 10.1381/09608920322509309.
- [12] Todurov IM, Kalashnikov OO, Kosiukhno SV, Plehutsa OI, Potapov OA, Khorevina KM. Low-calorie, high-protein, low-carbohydrate diet is an effective method of reducing excess body weight. *Fiziol Zh.* 2022;68(3):86-94. doi: 10.15407/fz68.03.086.
- [13] Vargas-Palacios A, Hulme C, Veale T, Downey CL. Systematic Review of Retraction Devices for Laparoscopic Surgery. *Surg Innov.* 2016;23(1):90-101. doi: 10.1177/1553350615587991.
- [14] Lainas P, Derienne J, Dammara C, Schoucair N, Devaquet N, Dagher I. Single-port Laparoscopic Surgery for the Treatment of Severe Obesity: Review and Perspectives. *Obes Surg.* 2020;30(7):2781-90. doi: 10.1007/s11695-020-04620-2.
- [15] Bann S, Butler A, Shaul T, Foley R. A technique for insertion of the laparoscopic Nathanson liver retractor. *Ann R Coll Surg Engl.* 2005;87(6):472-3.
- [16] Goel R, Shabbir A, Tai CM, Eng A, Lin HY, Lee SL, et al. Randomized controlled trial comparing three methods of liver retraction in laparoscopic Roux-en-Y gastric bypass. *Surg Endosc.* 2013;27(2):679-84. doi: 10.1007/s00464-012-2438-6.
- [17] Etoh T, Shiraishi N, Tajima M, Shiromizu A, Yasuda K, Inomata M, et al. Transient liver dysfunction after laparoscopic gastrectomy for gastric cancer patients. *World J Surg.* 2007 May;31(5):1115-20. doi: 10.1007/s00268-007-0237-3.
- [18] Meierhenrich R, Gauss A, Vandenesch P, Georgieff M, Poch B, Schütz W. The effects of intraabdominally insufflated carbon dioxide on hepatic blood flow during laparoscopic surgery assessed by transesophageal echocardiography. *Anesth Analg.* 2005;100(2):340-7. doi: 10.1213/01.ANE.0000143566.60213.0A.
- [19] Lohlun JC, Guirguis A, Wise L. Elevated liver enzymes following open Roux-en-Y gastric bypass for morbid obesity - does timing of liver retraction affect the rise in the levels of transaminases? *Obes Surg.* 2004;14(4):505-8. doi: 10.1381/096089204323013505.
- [20] Yassa NA, Peters JH. CT of focal hepatic injury due to surgical retractor. *AJR Am J Roentgenol.* 1996;166(3):599-602. doi: 10.2214/ajr.166.3.8623634.