INFLUENCE OF PNEUMOPERITONEUM DURING LAPAROSCOPIC SLEEVE RESECTION OF THE STOMACH ON THE HEMOCOAGULATION SYSTEM IN PATIENTS WITH MORBID OBESITY

ВПЛИВ ПНЕВМОПЕРИТОНЕУМУ ПІД ЧАС ЛАПАРОСКОПІЧНОЇ РУКАВНОЇ РЕЗЕКЦІЇ ШЛУНКА НА СИСТЕМУ ГЕМОКОАГУЛЯЦІЇ У ПАЦІЄНТІВ З МОРБІДНИМ ОЖИРІННЯМ

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Abstracts

Introduction. Obesity is an independent risk factor for venous thromboembolism (VTE) in men and women. Despite the fact that the risk of postoperative VTE is very high in obese patients, embolic episodes are less frequent in laparoscopic procedures compared to open procedures. Reducing excess body weight in patients with morbid obesity through bariatric surgery is becoming increasingly popular. Laparoscopic sleeve gastrectomy (SG) has proven to be the least traumatic of bariatric interventions, as it is performed as a one-stage procedure.

The category of obese patients (BMI ≥ 30), including patients with morbid obesity (BMI ≥ 40), is poorly represented in the aspect of adequate pressure of the carboxyperitoneum during laparoscopic bariatric interventions in terms of the development of VTE as a perioperative complication. Recently, the method of thromboelastography has been increasingly used for objectification.

Goals – to compare the NPTEG data obtained in intraoperative conditions from laparoscopic sleeve resection of the stomach patients with different levels of pneumoperitoneum pressure.

Materials and methods. The hemostasis system was studied in 50 patients aged 25–60 years with a BMI > 35 kg/m^2 who were treated for morbid obesity by sleeve gastrectomy. All patients were divided into 2 groups depending on the pressure of the carboxyperitoneum. Group 1 (n = 33) – underwent surgery with standard preset pressure of the pneumoperitoneum (12–15 mm Hg); Group 2 (n = 17) underwent surgery with pneumoperitoneum pressure values higher than standard (≥16 mmHg) due to visualization problems. The average duration of surgical intervention was 60–80 minutes. The duration of pneumoperitoneum was 45–60 minutes. The study of the hemostasis system was carried out with the help of low-frequency piezoelectric thromboelastography (LPTEH), immediately after hospitalization and for 30 minutes surgical procedure.

The results. In both groups of morbidly obese patients, with BMI ≥ 35 kg/m^2, who underwent SG, before surgery: ICC was increased by 12.62%, ICD was increased by more than 22.68%, MA was increased by 18.63%, IRCL – 31.17% higher than normal. In the patients of the 1st group for 30 minutes bariatrics, according to NPTEG data: ICC increased by 23.57%, compared to the norm; parameters of coagulation and fibrinolysis have a reliable upward trend, and an increase in fibrinolysis activity is observed. In the patients of the 2nd group, at the same time, the ICC increased by 38.71%, the ICD increased by 69.03%, the MA increased by 98.93% compared to the norm, and the IRCL was increased by 118.73% higher than norm.

Conclusions. The higher pressure of the pneumoperitoneum significantly affects the data of NPTEG in comparison with the standard in intraoperative conditions; this may increase the intra- and postoperative risk of VTE.

Key words: Bariatrics, gastric sleeve resection, laparoscopy, carboxyperitoneum, VTE, thromboelastography.

Вступ. Ожиріння є незалежним фактором ризику венозної тромбоемболії (ВТЕ) у чоловіків та жінок. Незважаючи на те, що у пацієнтів з ожирінням ризик післяопераційної ВТЕ дуже високий, епізоди емболії рідше трапляються у разі лапароскопічних утручань порівняно з «відкритими». Зниження надлишку маси тіла у пацієнтів з морбідним ожирінням шляхом баріатричної хірургії стає дедалі популярнішим. Лапароскопічна рукавна резекція шлунка (SG) зарекомендувала себе як найменш травматична серед баріатричних втручань, адже проводиться як одноетапна процедура.

Категорія пацієнтів з ожирінням (ІМТ ≥ 30), у тому числі пацієнтів з морбідним ожирінням (ІМТ ≥ 40), погано представлена в аспекті адекватного тиску карбоксиперитонеуму під час лапароскопічних баріатричних утручань з точки зору розвитку ВТЕ як періопераційних ускладнень. Для об'єктивізації останнім часом дедалі частіше використовують метод тромбоеластографії.

Мета дослідження – порівняти дані низькочастотної п'єзоелектричної тромбоеластографії (НПТЕГ), отримані в інтраопераційних умовах від пацієнтів лапароскопічної рукавної резекції шлунка з різними рівнями тиску пневмоперитонеуму.

Матеріали і методи. Вивчено систему гемостазу у 50 пацієнтів віком 25–60 років з ІМТ > 35 кг/м^2, які проходили лікування з приводу морбідного ожиріння методом рукавної резекції шлунка. Усі пацієнти були поділені на 2 групи залежно від тиску карбоксиперитонеуму. Група 1 (n = 33) – перенесли операцію зі стандартною передустановкою тиску пневмоперитонеуму (12–15 мм рт. ст.); група 2 (n = 17) перенесла операцію з цифрами тиску пневмоперитонеуму вище стандартних (≥16 мм рт. ст.) через проблеми із візуалізацією. Середня тривалість хірургічного втручання становила 60–80 хв. Тривалість пневмоперитонеуму становила 45–60 хв. Дослідження системи гемостазу проводилося за допомогою НПТЕГ одразу після госпіталізації та на 30 хв. хірургічної процедури.

Результати. В обох групах пацієнтів з морбідним ожирінням, з ІМТ ≥ 35 кг/м^2, які підлягали SG, до операції: ІКК було збільшено на 12,62%, ІКД – більш ніж на 22,68%, МА було збільшено на 18,63%, ІРЛС – 31,17% вище за норму. У пацієнтів 1-ї групи на 30 хв. баріатрії, за даними НПТЕГ: ІКК збільшилось на 23,57% порівняно з нормою; параметри коагуляції та фібринолізу мають надійну тенденцію до зростання та спостерігається збільшення активності фібринолізу. У пацієнтів 2-ї групи в той же час ІКК збільшився на 38,71%, ІКД зросло на 69,03%, МА підвищена на 98,93% порівняно з нормою, а ІРЛЗ був підвищений на 118,73% вище за норму.

Висновки. Вищий тиск пневмоперитонеуму значно впливає на дані НПТЕГ порівняно зі стандартом в інтраопераційних умовах; це може збільшити внутрішньо- та післяопераційний ризик ВТЕ.

Ключові слова: баріатрія, рукавна резекція шлунка, лапароскопія, карбоксиперитонеум, ВТЕ, тромбоеластографія.

Introduction. According to "World health statistics 2012", there are more than 1.7 billion people in the world who are overweight or obese. Obesity has become an epidemic [15]. In 2022 2.5 billion adults aged 18 and over were overweight, including more than 890 million obese adults. This corresponds to 43% of adults aged 18 and over (43% of men and 44% of women) who were overweight; an increase from 1990, when 25% of adults aged 18 and older were overweight. About 16% of the world's adults aged 18 and over were obese in 2022. Between 1990 and 2022 the prevalence of obesity worldwide will more than double, according to the Economic Impacts of Overweight and Obesity analysis [11].

Obesity is an independent risk factor for venous thromboembolism (VTE) in men and women [3]. According to the proposed mechanism of thrombus formation in obesity according to L. Freeman, 2010, there are some disorders in the hemostasis system, due to which obesity can be considered as a prothrombotic state. These include increased activity of platelets (leptin and adiponectin, insulin resistance, blood stasis, inflammation), procoagulation state (increased production of thrombin, increased levels of tissue factor, fibrinogen, factor VII and factor VIII), impaired fibrinolysis of plasminogen activator and fibrinolysis inhibitor, activated by thrombin), as well as activation of endothelial cells due to tissue hypoxia [3; 9; 13]. Based on the above, obesity interferes with internal and external coagulation pathways, as well as with anticoagulant mechanisms, which leads to a hypercoagulable state.

Laparoscopic surgery has gained its popularity due to many advantages, such as low trauma and short stay of the patient in the hospital, quick recovery after surgery, absence of severe pain, absence of postoperative scars, which are observed, for example, during laparotomy. Despite the fact that the risk of postoperative venous thromboembolism (VTE) is very high in obese patients, embolic episodes are less frequent in laparoscopic procedures compared to open procedures. Reducing excess body

weight in patients with morbid obesity through bariatric surgery is becoming more and more popular, because bariatrics has been proven to be an effective tool in the treatment of obesity and related diseases. Bariatric procedures such as laparoscopic gastric banding (LAGB), Roux-en-Y gastric bypass (RYGBP), biliopancreatic bypass (BPD), and sleeve gastroplasty (SG) are well established. LAGB is a purely restrictive technique, while RYGBP and BPD are considered primarily malabsorptive procedures. SG was developed as a two-stage operation, but is currently performed as a one-stage procedure [16].

SG is highly effective and beneficial for morbidly obese patients and patients with a BMI greater than 50. It can be planned as a first-stage procedure. It can also be performed safely in patients with comorbidities and those awaiting transplantation. SG has a shorter operating time than other gastric bypass procedures. It is really difficult to reach the biliary tract by gastric bypass methods, but there is no technical difficulty with SG. It may also be preferred in patients with Crohn's disease and ulcerative colitis or those who require regular upper gastrointestinal examinations. This may be beneficial for patients who have undergone lower gastrointestinal surgery and have small bowel adhesions. It is also recommended for patients because gastric bypass can cause changes in the serum levels of some drugs. Many bariatric surgeons recognize gastroesophageal reflux disease and Barrett's esophagus as contraindications. None of the studies demonstrated a risk of conversion of Barrett's disease to high-grade dysplasia or adenocarcinoma after SG. SG can be performed in adolescents with severe comorbidities who have a body mass index greater than 35. It is more effective than diet and exercise. This allows you to cure or alleviate both somatic and physiological problems associated with obesity. SG has theoretical advantages, especially for this patient population. The rate of surgical or nonsurgical complications is lower with SG than with gastric bypass [6].

As in any laparoscopic surgery, carboxyperitoneum is used during laparoscopic SG for improved visualization. According to accepted recommendations, a low pressure of 11–13 mm Hg is used art., however, in some cases, in the presence of poor visualization, a rather high pneumoperitoneum ≥16 mm Hg is used, which contributes to the development of complications from the cardiovascular system, the blood coagulation system, including venous thromboembolism (VTE), etc. [5; 10].

The benefits of bariatric surgery are undeniable, as are the risks [16]. In a 2004 meta-analysis (USA), the 30-day postoperative mortality rate was 0.1% for purely restrictive procedures (gastric banding or gastroplasty), 0.5% for gastric bypass, and 1.1% for biliopancreatic diversion [1; 2]. Venous thromboembolism (VTE), which includes deep vein thrombosis (DVT) and its complication, pulmonary embolism (PE), is a common cause of morbidity and mortality after bariatric surgery. However, the postoperative rate of VTE varies widely: from 0.2% to 1.3% within 30 days [4; 5; 7] up to 0.42% within 90 days [14]. Postoperative episodes of PE with fatal outcomes were also not uncommon. An autopsy of 10 patients who died after Rouxen-Y gastric bypass surgery (RYGP) showed that 3 of them died of PE [8]. The following postoperative risk factors for VTE in morbidly obese patients undergoing bariatric surgery have been identified: type of surgery (high risk in open compared to laparoscopic surgery and high risk in RYGP compared to adjustable gastric banding); the patient is over 50 years old, postoperative failure of anastomosis, history of smoking, as well as previous VTE [4; 5].

However, the category of obese patients (BMI ≥ 30), including patients with morbid obesity (BMI ≥ 40), is poorly represented in the aspect of adequate pressure of the carboxyperitoneum during laparoscopic bariatric interventions in terms of the development of VTE as a perioperative complication. Despite the proven high risk of developing thromboembolic complications in obese patients, including patients undergoing bariatric surgery, the issue of choosing a safe intra-abdominal pressure is relevant. But to answer these questions, we must clearly understand the functional state of the vascular-platelet, coagulation link of the system of hemostasis and fibrinolysis in this category of patients. Recently, the method of thromboelastography has been increasingly used for objectification. Low-frequency piezoelectric thromboelastography (LPTEG) is the most effective method of investigating hemostatic potential (HP), which is capable of objectively displaying the vascular-platelet component, the coagulation link of the hemostasis system, and fibrinolysis.

The device provides the calculation of the relevant parameters, which are displayed in

the form of a graph (Fig. 1; Fig. 2) and a table with digital values: A0 – the initial indicator of the aggregate state of the blood; R(t1) is the time of the contact phase of coagulation; ICC – intensity of contact coagulation; KTA – constant of thrombin activity; BCT – blood coagulation time; ICD – intensity of coagulation drive; ICP – the intensity of polymerization of the clot; MA – maximum clot density; T is the time of formation of the fibrin-platelet structure of the clot (time of total blood coagulation); IRCL is the intensity of clot retraction and lysis [12].

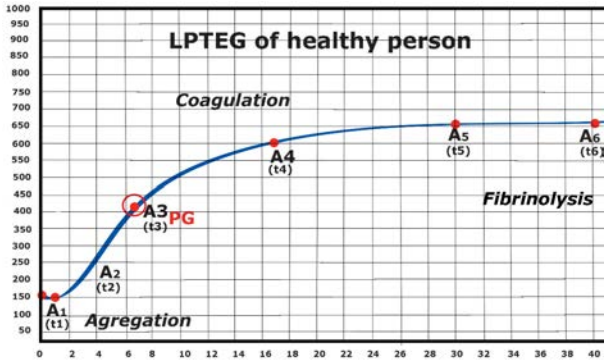

Fig. 1. Integral thromboelastogram based on the results of studies of the hemostasis system in a group of healthy volunteers

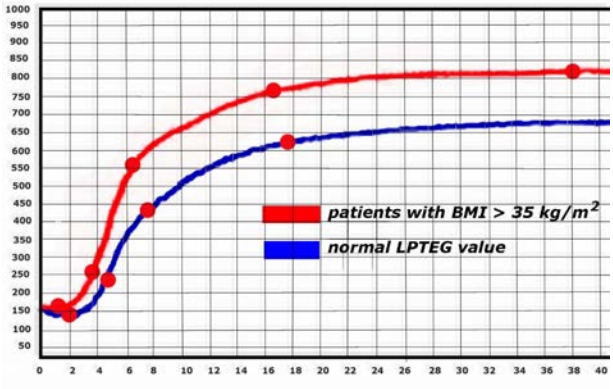

Fig. 2. Integral thromboelastogram based on the results of studies of the hemostasis system in a group of healthy volunteers and obese patients

Goals – to compare the NPTEG data obtained in intraoperative conditions from laparoscopic surgery patients with different levels of pneumoperitoneum pressure.

Materials and methods.

The hemostasis system was studied in 50 patients aged 25–60 years with a BMI > 35 kg/m^2 who were treated for morbid obesity by sleeve gastrectomy. All patients were divided into 2 groups depending on the pressure of the carboxyperitoneum. Group 1 (n = 33) – underwent surgery with standard preset pressure of the pneumoperitoneum (12–15 mm Hg); Group 2 (n = 17) underwent surgery with pneumoperitoneum pressure values higher than standard (≥16 mmHg) due to visualization problems. The average duration of surgical intervention was 60–80 minutes. The duration of pneumoperitoneum was 45–60 minutes.

Further monitoring of the hemostasis system was carried out using low-frequency piezoelectric thromboelastography (LPTEG) immediately after hospitalization and at 30 minutes surgical procedure. Blood for follow-up was taken from the cubital vein using the standard technique.

The current blood throat constants have been verified:

– Intensity of contact coagulation (ICC)
– Intensity of coagulation drive (ICD)
– Maximum thickness of the clot (MA)
– Fibrinolytic activity – index of clot retraction and lysis (IRCL).

Results.

In both groups of morbidly obese patients with BMI ≥ 35 kg/m^2, who underwent SG, before surgery: ICC was increased by 12.62%, ICD was increased by 22.68%, MA was increased by 18.63%, IRCL – 31.17% higher than the norm.

Patients of the 1st group at 30 min. bariatrics, according to NPTEG data (Table 1): ICC increased by 23.57%, equal to the norm; the parameters of coagulation and fibrinolysis show a reliable trend until an increase and an increase in the activity of fibrinolysis is avoided. In patients of the 2nd group, at the same hour, ICC increased by 38.71%, ICD increased by 69.03%, MA moved by 98.93% equal to the norm, and IRCL moved by 118.73% higher than normal (Fig. 3).

Conclusions. The higher pressure of the pneumoperitoneum significantly affects the data of NPTEG in comparison with the standard in intraoperative conditions; this may increase the intra- and postoperative risk of VTE.

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Table 1

Results of monitoring the hemostasis system based on LPTEG data

LPTEG data tracking results		ICC	ICD	MA	IRCL
before surgery		**↑* 12.62%**	**↑ 22.68%**	**↑ 18.63%**	**↑ 31.17%**
30 min.	1st group	**↑ 23.57 %**	**↑ 34.57%**	**↑ 74.52%**	**↑ 91.18%**
	2nd group	**↑ 38.71 %**	**↑ 69.03%**	**↑ 98.93%**	↑ 118.73%

Note *↑↓ – increase/decrease relative to the norm (N)

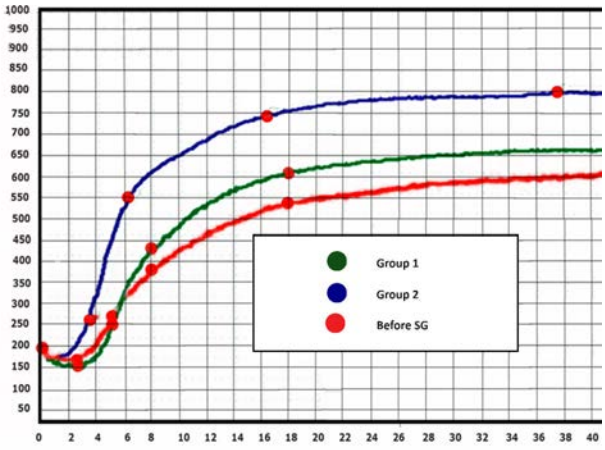

Fig. 3. Integral thromboelastogram according to the results of studies of the hemostasis system before laparoscopic sleeve resection of the stomach and in patients with different pressures of the carboxyperitoneum

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