

## CORRECTIVE EFFECT OF GASTRIC LONGITUDINAL RESECTION IN PATIENTS WITH MORBID OBESITY ON HEMOSTASIS INDICATORS DISORDERS

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### ABSTRACT

Obesity, according to expert evidence, leads to a risk of cardiovascular diseases by 4 times and mortality from cancer by 2 times. Evaluation of hemostasis disorders in patients with morbid obesity and study of the significance of the practice of longitudinal resection of the stomach. From 2019 to 2022 years in our clinic were performed 231 metabolic and bariatric surgeries, including 82 minigastric bypasses (MGS) and 149 sleeve resection (SG). Over the years, SG was performed in 149 patients with different body mass index. 84 (56,3%) patients suffering from morbid obesity had grade III obesity, 65 (43,7%) had grade II obesity. The analyzes performed showed that patients suffering from morbid obesity have a tendency to hypercoagulability in vascular-platelet and coagulation hemostasis.

In morbid obesity, depending on its severity, statistically significant disturbances in the value of hemostasis parameters of patients were observed, a moderate positive association with BMI was revealed; genetic predisposition, as well as in patients with concomitant diseases such as diabetes mellitus.

**Key words:** morbid obesity, hemostasis parameters, sleeve gastrectomy.

**МОРБИД СЕМИЗЛИКДА ОШҚОЗОН БЎЙЛАМА РЕЗЕКЦИЯСИ  
АМАЛИЁТИНИНГ БЕМОРЛАР ГЕМОСТАЗ КЎРСАТКИЧЛАРИ  
БУЗИЛИШЛАРИНИ КОРРЕКЦИЯЛОВЧИ ТАЪСИРИ**

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### АННОТАЦИЯ

Семизлик эксперт маълумотларига кўра, юрак-қон томир касалликлари хавфини 4 бараварга ва саратон касаллигидан ўлимни 2 бараварга ошишига олиб келади. Морбид семизлик билан оғриган беморлар гемостаз бузилишларини баҳолаш ва уларни яхшилашда ошқозон бўйлама резекцияси амалиётининг аҳамиятини ўрганиш. Клиникамизда 2019 йилдан 2022 йилгача 231 та метаболик ва бариатрик жарроҳлик операциялари ўтказилди, шундан 82 таси минигастрошунтлашг(МГШ) ва 149 тасида ошқозон бўйлама резекцияси(ОБР) амалиёти ўтказилган. Ушбу йиллар давомида турли тана массаси индекси билан мурожат этган 149 нафар беморларга ОБР операцияси қилинди. Морбид семизлик билан оғриган беморларнинг 84(56,3%)тасида III даражали ва 65(43,7%) да II даражали семизлик аниқланди. Олиб борилган таҳлиллар шуни кўрсатдики морбид семизликдан азият чекаётган беморларда томир-тромбоцитар ва коагуляцион гемостазда гиперкоагуляцияга мойиллик мавжудлигидан далолат беради.

Морбид семизликда, унинг оғирлик даражасига боғлиқ холда, беморларнинг гемостаз кўрсаткичлари миқдорида статистик ишонарли бузилишлар кузатилиб, ТМИ билан ўртача мусбат боғланиш аниқланди; наслий мойиллиги, ҳамда қандли диабет каби коморбит ҳолатлари бўлган беморларда яна ҳам юқори намоён бўлади.

**Калит сўзлар:** морбид семизлик, гемостаз кўрсаткичлари, ошқозоннинг бўйлама резекцияси.

## КОРРИГИРУЮЩЕЕ ВЛИЯНИЕ ПРОДОЛЬНОЙ РЕЗЕКЦИИ ЖЕЛУДКА У БОЛЬНЫХ МОРБИДНЫМ ОЖИРЕНИЕМ НА НАРУШЕНИЯ ПОКАЗАТЕЛЕЙ ГЕМОСТАЗА

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### АННОТАЦИЯ

Ожирение, по экспертным сведениям, приводит к повышению риску сердечно-сосудистых заболеваний в 4 раза и смертности от онкологических заболеваний в 2 раза. Оценка нарушений гемостаза у больных с морбидным ожирением и изучение значения практики продольной резекции желудка. С 2019 по 2022 г. в нашей клинике была выполнена 231 метаболическая и бариатрическая операция, из них 82 минигастрошунтирования (МГШ) и 149 продольных резекций желудка (ПРЖ). За эти годы было произведено ПРЖ у 149 больных с различным индексом массы тела. У 84 (56,3%) пациентов, страдающих морбидным ожирением, было ожирение III степени, у 65 (43,7%) — ожирение II степени. Проведенные анализы показали, что у больных, страдающих морбидным ожирением, имеется тенденция к гиперкоагуляции в сосудисто-тромбоцитарном и коагуляционном гемостазе.

При морбидном ожирении в зависимости от его тяжести наблюдались статистически достоверные нарушения величины показателей гемостаза больных, выявлена умеренная положительная ассоциация с ИМТ; генетическая предрасположенность, а также у пациентов с сопутствующими заболеваниями, такими как сахарный диабет.

**Ключевые слова:** морбидное ожирение, показатели гемостаза, продольная резекция желудка.

## INTRODUCTION

Obesity is the most dangerous and serious risk factor for the life of patients. More than 1 billion adults are overweight and at least 300 million people are obese (BMI over 30 kg/m<sup>2</sup>) [17]. The body mass index (BMI) in men and women increased by 0.4-0.5 kg/m<sup>2</sup> per decade [18].

We know that prevention is the long-term solution to this vital public health problem, but prevention may not always be successful and sustainable. In addition, current conservative therapies, including non-drug and drug treatments, fall far short of the desired success in long-term weight loss [4,24].

It has been scientifically proven that people with certain degrees of obesity (I, II or III) are at higher risk of obesity-related diseases, comorbidities, lower quality of life and increased mortality to a greater extent than people in the normal BMI range (18, 5–24,9) [23,6].

It is known that morbid obesity often correlates with arterial hypertension, dyslipidemia, prediabetes and type 2 diabetes mellitus [16].

Many authors have scientifically and clinically proven that bariatric surgery in adult morbidly obese patients may be the most appropriate treatment option for sustaining weight loss and obesity-related management [25].

Bariatric surgery is recommended in patients with morbid obesity and a combination of the above comorbidities [20, 8, 7, 19]. Recently, the most frequent bariatric surgeries are laparoscopic sleeve gastrectomy (LSG), mini gastric bypass (MGB), Roux-en-Y gastric bypass (RYGB), and duodenal switch (DS). Laparoscopic sleeve gastrectomy can give results such as MGB, RYGB and DS without malabsorption problems [15,9].

Sleeve gastrectomy is a new, safe and effective method of surgical treatment of obesity with higher survival rates and low patient complication rates [24,5]. This operation was originally described by Hess (1988) as part of duodenal switch biliopancreatic shunting [10]. Sleeve gastrectomy is currently widely performed as an independent laparoscopic operation [11]. Since its first introduction in 2004 as a stand-alone laparoscopic procedure in bariatric surgery, LSG has proven to be effective in sustained, long-term weight loss and improvement in comorbidities [14].

Objective: To study the significance of sleeve gastrectomy (SG) in evaluating and improving hemostasis disorders in morbidly obese patients.

## MATERIALS AND METHODS

From 2019 to 2022, 231 metabolic and bariatric surgeries were performed in our clinic, of which 82 were minigastroshunt (MGS) and 149 were sleeve gastrectomy (SG). In recent years, the number of patients with morbid obesity has increased, and the scope of SG surgery has increased accordingly. During these years, 149 patients

with different body mass index were operated. 18 (12.1%) of them are men and 131 (87.9%) are women. The age of the operated patients ranged from 21 to 60 years (average  $38.3 \pm 5.9$  years). 84 (56.3%) of patients suffering from morbid obesity had level III obesity and 65 (43.7%) had level II obesity. 90 (60.4%) patients had one or more concurrent comorbidities, including arterial hypertension 47 (31.5%), gallstone disease 23 (15.2%), diabetes 11 (7.3%), osteoarthritis 11 (7.3%), hiatal hernia 7 (4.7%), ischemic heart disease 9 (6.0%).

According to the genetic anamnesis of patients with morbid obesity, 46 (30.8%) patients have a genetic predisposition to obesity. In the investigation, it was found that 33 (22.1%) patients received various types of conservative treatment before operative treatment, and in most cases, operative treatment was applied after conservative treatment was ineffective. Among the studied patients, depression was found in 22 (15.0%) patients, sleep apnea in 14 (9.5%), infertility in 6 (4%) women, and decreased libido in 12 (8.0%) patients. Such changes were assessed as complications related to morbid obesity, and these indicators were dynamically observed after the operation[3].

It is known that, especially as a result of morbid obesity, cell stress occurs as a result of the increase in fat mass of adipocytes, which leads to the production of many pro-inflammatory cytokines and chemoattractants for immunocytes, especially macrophages, and their accumulation in adipose tissue. As a result, the induction of pro-inflammatory cytokine production by accumulated macrophages and adipocytes leads to the development of a characteristic mild but chronic inflammatory state in morbid obesity [26,27].

Pro-inflammatory cytokines produced in chronic inflammatory conditions activate endotheliocytes, increase production of procoagulant and adhesion factors, and decrease anticoagulant factors, leading to thrombin generation and platelet activation [12]. Similarly, obesity-induced lipid profile disturbances increase the development of atherosclerosis, which causes endothelial dysfunction. In addition, increased production of plasminogen activator inhibitor-1 (PAI-1) factor in obesity has a negative effect on the process of fibrinolysis [21]. These factors create conditions for the emergence of a specific hypercoagulable state in morbid obesity, and the frequency of thrombosis and thromboembolism in such patients is high.

## RESULTS OBTAINED AND DISCUSSION

Coagulation factors are of great practical importance in evaluating the effectiveness of surgical procedures performed in the main and control groups in patients with morbid obesity. To study the vascular-platelet stage of hemostasis, we counted the number of platelets in the blood analysis. The study showed that in the control group this indicator was  $244 \pm 38.9 \times 10^9/l$ , while the average amount of platelets in the patients in the main and control groups was  $\dots \times 10^9/l$  and  $\dots \times 10^9/l$  did. The

analysis of the number of thrombocytes according to the level of obesity in the main and control groups of patients with 2nd degree obesity showed this indicator ...x10<sup>9</sup>/l and ...x10<sup>9</sup>/l, and in 3rd degree obesity - ...x10<sup>9</sup>/l and ...x10<sup>9</sup>/l, respectively. The obtained results showed that thrombocytosis develops to a certain degree in obesity and that this indicator depends on the degree of obesity. This showed an increase in platelet function and a tendency to hypercoagulability in patients.

Coagulation hemostasis consists of a cascade of reactions involving plasma factors. In the group of healthy donors, AQTV was 32.1±0.93 seconds, while in the main and control group patients suffering from obesity, AQTV time in plasma was reduced to 21.82±0.50 (P<0.01) and 24.98±0.57 (P<0.01) seconds. When we analyzed the AQTV indicator according to the level of obesity, if it was reduced to 23.07±0.74 (P<0.01) and 24.98±0.57 (P<0.01) seconds in 2nd degree obesity, it was 20.98±0.65 (P<0.001) and 25.75±0.71 in patients with 3rd degree obesity. (P<0.01) was found to be reduced to seconds, that is, it did not depend much on the level of obesity. Reduction of AChTV index in obese patients compared to healthy donors indicated a hypercoagulable shift in the first stage of plasma hemostasis (Table 1).

**Table 1**

**Assessment of the first stage of blood coagulation in obese patients with AQTV (seconds), M±m**

Groups	Main group	Control group
General	21,82±0,50**	24,98±0,57**
2nd degree obesity, n=20	23,07±0,74**	24,98±0,57**
3nd degree obesity, n=25	20,98±0,65***	25,75±0,71**
Healthy donors, n=15	32,1±0,93	

Note: \* - the difference compared to the indicators of the group of healthy donors is reliable (\*-R<0.05; \*\*-R<0.01; \*\*\* - R<0.001)

To characterize the second stage of plasma hemostasis, prothrombin time, prothrombin index and XMM were studied (Table 2). Prothrombin time, PTI XMM did not change much in obese patients and did not differ from normal parameters.

**Table 2**

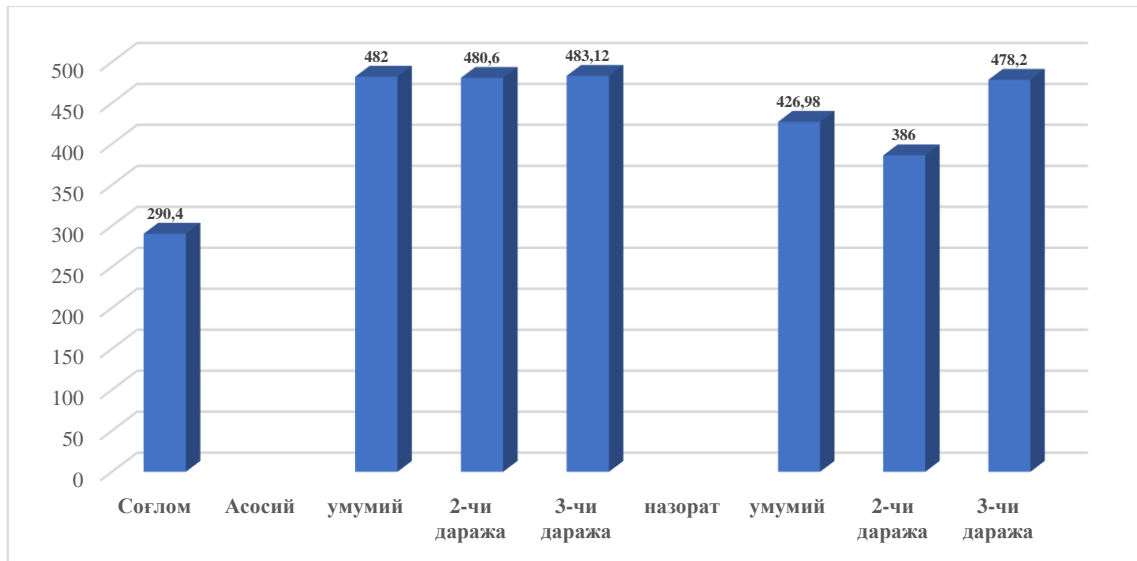
**Assessment of the second stage of blood coagulation in obese patients, M±m**

Groups	PT, sec	ПТИ, %	XMM
Healthy n=12	12,81±1,14	98,52±7,23	1,00±0,09
Main, n=46	12,99±0,29	98,57±1,64	1,09±0,04
2nd degree, n=20	13,24±0,38	98,09±2,85	1,14±0,04
3 <sup>rd</sup> degree, n=26	12,85±0,41	98,96±1,95	1,05±0,06
Contro, n=45	13,71±0,37	99,06±1,93	1,18±0,05
2nd degree, n=25	13,71±0,37	99,06±1,93	1,18±0,05
3 <sup>rd</sup> degree, n=20	13,44±0,57	100,20±2,65	1,22±0,08

Note: \* - the difference compared to the indicators of the group of healthy donors is reliable (\*-R<0.05; \*\*-R<0.01; \*\*\* - R<0.001)

The study of indicators of the second stage of blood coagulation showed that there were no change in the second stage of coagulation hemostasis in obese patients.

To characterize the third stage of blood coagulation, the amount of fibrinogen was determined (see Figure 1). The study of the amount of fibrinogen showed a significant increase in the concentration of fibrinogen, which indicated the existence of a hypercoagulable shift in the third stage of blood clotting coagulation hemostasis. In particular, the amount of fibrinogen in the patients of the main and control groups increased by 1.66 (P<0.01) and 1.47 (P<0.015) times compared to the standard values and amounted to 482.00±21.66 and 426.98±16.83 mg%. In the 2nd degree of obesity, the amount of fibrinogen was 1.65 (P<0.01) and 1.33 ( P<0.05) times increased to 480.60±31.31 and 386.00±15.88 mg%. In the main and control groups with 3rd degree obesity, this increase was 1.66 (P<0.01) and 1.65 (P<0.01), and these indicators were 483.12±28.81 and 478.20±29, increased to 10 mg%.In the group of healthy donors, this indicator was 290.4±60.5 mg%.



1. picture. The amount of fibrinogen in the blood serum of patients (mg%).

In conclusion, the study of the third stage of blood coagulation showed hypercoagulability in all groups with IMTV compared to the control group.

So, in general, in patients with obesity, significant shifts in vascular thrombotic and coagulation hemostasis are observed, indicating the presence of a tendency to hypercoagulation. This, in our opinion, can be associated with the activation of vascular thrombotic hemostasis, the reduction of NO oxide production due to atherosclerotic damage to the endothelium. A decrease in the amount of nitric oxide increases platelets and erythrocytes and increases blood viscosity. At the same time, the insulin resistance observed in obesity leads to the activation of the synthesis of plasminogen activator inhibitor, which leads to the reduction of fibrinolysis, and with it, the activation of other procoagulant factors [1].

As a proof of these opinions, we conducted a correlational analysis between the atherosclerosis coefficient and hemocoagulation markers, which provide information about the state of atherosclerosis that induces hemocoagulation dysfunction in the case of obesity, according to the indicators before surgery. The obtained results showed a weak inverse relationship between the atherogenic coefficient and prothrombin time in obese patients ( $r=-0.33$ ;  $P<0.05$ ), a weak inverse relationship with XMM ( $r=-0.39$ ;  $P<0.05$ ), and a statistically reliable correlation with AQTV ( $r=0.28$ ;  $P>0.05$ ) and fibrinogen ( $r=-0.21$ ;  $P>0.05$ ). Anish was not detected.

It is known that arterial hypertension in metabolic syndrome is caused by biologically active substances produced in adipose tissue, including aldosterone secretion enhancing factor synthesized in adipocytes [2,22]. However, it should be said that arterial hypertension itself is the main factor in the development and acceleration of atherosclerosis. The main reason for this is endothelial dysfunction. According to



the authors, this results in dangerous circulation, and endothelial dysfunction leads to cardiovascular diseases, which in turn exacerbate endothelial damage.

Similarly, changes in coagulation parameters depending on the degree of obesity as a result of longitudinal resection of the stomach performed in the main group during the study were examined (Table 3). When we analyzed the first stage of coagulation hemostasis, a tendency to lengthen AQTV was observed in the main and control groups 6 months after surgery. No differences were found between the groups, and all scores were statistically significantly shorter than the norm. In particular, the time of AQTV in the plasma in patients of the main and control groups was shorter by 1.32 ( $R < 0.05$ ) and 1.27 ( $R < 0.05$ ) compared to the standard indicators. In 2nd degree obesity, they were found to be 1.29 ( $R < 0.05$ ) and 1.28 ( $R < 0.05$ ) times, and in 3rd degree obesity, they were 1.34 ( $R < 0.05$ ) and 1.26 ( $R < 0.05$ ) times shorter than normal values. The obtained results show that the tendency to hypercoagulability remains in the first stage of plasma hemostasis.

**Table 3**

**Effect of bariatric surgery on AQTV (seconds),  $M \pm m$**

Groups	Main group		Control group	
	Before treatment	After 6 months	Before treatment	After 6 months
General	21,82±0,50*	24,40±0,63*	24,98±0,57*	25,24±0,53*
2nd degree, n=20	23,07±0,74*	24,93±1,00*	24,98±0,57*	25,04±0,72*
3rd degree, n=25	20,98±0,65*	23,99±0,81*	25,75±0,71*	25,50±0,81*
Healthy donors , n=15	32,1±0,93			

Note: \* - the difference compared to the indicators of the group of healthy donors is reliable ( $R < 0.05$ ); ^ - differences between pre-treatment and post-treatment indicators are reliable ( $R < 0.05$ ).

The parameters of the second stage of plasma hemostasis in the main and control groups did not differ significantly from their pretreatment values after surgery. Prothrombin time (Table 4), PTI (Table 5) and XMM (Table 6) did not change much in obese patients and did not differ from normal indicators..

**Table 4**

**Effect of bariatric surgery on prothrombin time (seconds), M±m**

Groups	Main group		Control group	
	Before treatment	After 6 months	Before treatment	After 6 months
General	12,99±0,29	10,67±0,24	37 13,71±0,	35 11,53±0,
2 <sup>nd</sup> degree, n=20	13,24±0,38	10,77±0,28	37 13,71±0,	54 11,45±0,
3 <sup>rd</sup> degree, n=25	12,85±0,41	10,61±0,37	57 13,44±0,	42 11,63±0,
Healthy donors, n=15	12,81±1,14			

Note: \* - the difference compared to the indicators of the group of healthy donors is reliable (R<0.05).

**Table 5**

**Effect of bariatric surgery on prothrombin index (%) indicator, M±m**

Groups	Main group		Control group	
	Before treatment	After 6 month	Before treatment	After 6 months
General	98,57±1,64	80,07±1,33	93 99,06±1,	62 85,44±1,
2 <sup>nd</sup> degree, n=20	98,09±2,85	80,75±2,27	93 99,06±1,	32 85,16±2,
3 <sup>rd</sup> degree, n=25	98,96±1,95	79,54±1,62	,65 100,20±2	26 85,80±2,
Healthy donors, n=15	98,52±7,23			

Note: \* - the difference compared to the indicators of the group of healthy donors is reliable (R<0.05).

**Table 6**

**Effect of bariatric surgery on XMM indicator, M±m**

Groups	Main Group		Control group	
	Before treatment	After 6 months	Before treatment	After 6 months
General	1,09±0,04	0,95±0,03	5 1,18±0,0	3 1,00±0,0
2 <sup>nd</sup> degree, n=20	1,14±0,04	0,95±0,03	5 1,18±0,0	5 1,03±0,0
3 <sup>rd</sup> degree, n=25	1,05±0,06	0,95±0,04	8 1,22±0,0	3 0,97±0,0
Healthy donors, n=15	1,00±0,09			

Note: \* - the difference compared to the indicators of the group of healthy donors is reliable ( $R < 0.05$ ).

That is, it showed that there were no changes in the second stage of coagulation hemostasis.

A statistically significant decrease of 1.46 ( $R < 0.05$ ) and 1.34 ( $R < 0.05$ ) was observed in the main and control groups after 6 months of surgery, which represents the 3rd stage of coagulation hemostasis (Table 7). In the 2nd degree of obesity, fibrinogen content decreased by 1.35 ( $P < 0.05$ ) and 1.32 ( $P < 0.05$ ) times in the groups, compared to the values before treatment, while in patients with the 3rd degree of obesity, it decreased by 1.59 ( $P < 0.01$ ) and 1.36 ( $P < 0.01$ ). Plasma fibrinogen content remained statistically significantly higher than that of the healthy donor group.

**Table 7**  
**Effect of bariatric surgery on fibrinogen content (mg%),  $M \pm m$**

Groups	Main group		Control group	
	Before treatment	After 6 months	Before treatment	After 6 months
General	482,0±21,7*	330,4±15,0 <sup>^</sup>	427,0±16,8*	319,0±10,2 <sup>^</sup>
2nd degree, n=20	480,6±31,3*	356,7±25,7 <sup>^</sup>	386,0±15,9*	293,2±11,1 <sup>^</sup>
3rd degree, n=25	483,1±28,8*	310,1±17,0 <sup>^</sup>	478,2±29,1*	351,1±15,7 <sup>^</sup>
Healthy donors, n=15	290,4±60,5			

Note: \* - the difference compared to the indicators of the group of healthy donors is reliable ( $R < 0.05$ ); <sup>^</sup> - differences between pre-treatment and post-treatment indicators are reliable ( $R < 0.05$ ).

In all parameters presented in Table 7, a statistically significant positive change was found after longitudinal resection of the stomach compared to the control group. Despite the decrease in all indicators, the tendency to increase compared to the norm remained. The obtained results showed that bariatric procedures in obesity had a positive effect on the 3rd stage of coagulation hemostasis and led to the elimination of hypercoagulation. These results indicate that the surgical procedure performed in the main group was an effective treatment regardless of the degree of obesity in the patients.

The results obtained in this way indicate a tendency to hypercoagulability in vascular-platelet and coagulation hemostasis in obese patients. It was not determined that it was related to the level of obesity, which is characteristic of the first and third

stages of obvious coagulation hemostasis. In order to determine the association of serum lipid parameters with TMI, we analyzed correlational associations. The obtained results revealed negative medium correlations between the amount of XS in ZYuLPs and TMI in the main and control groups. Triacylglycerides, total cholesterol, XS content in ZPLPs and glucose were moderately positive. The obtained results indicate that such patients have a tendency to diseases of the cardiovascular system.

A clear statistically significant positive change was found after longitudinal resection of the stomach compared to the control group. Despite the decrease in all indicators, the tendency to increase compared to the norm remained. The obtained results showed that bariatric procedures in obesity had a positive effect on the 3rd stage of coagulation hemostasis and led to the elimination of hypercoagulation. These results indicate that the surgical procedure performed in the main group was an effective treatment regardless of the degree of obesity in the patients.

### CONCLUSIONS

1. In morbid obesity, depending on its severity, statistically reliable disturbances in the amount of hemostasis indicators of patients were observed, and an average positive connection with TMI was determined.

2. Despite the obvious statistically significant positive changes after longitudinal resection of the hemostasis of the control group, the tendency to increase the coagulation hemostasis in the 1st and 3rd stages compared to the norm remained. Surgery performed in the main group showed that the treatment was effective regardless of the degree of obesity in patients.

3. Thus, from the point of view of the long-term effects of bariatric surgery, including weight loss and remission of concomitant diseases (arterial hypertension, T2DM, arthralgia, dyslipidemia, and other diseases associated with obesity), the effects obtained from LSG prove the high effectiveness of this operation in patients with morbid obesity.

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