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Analysis of risk factors associated with complications after laparoscopic gastric bypass in patients with obesity

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Global data indicate that complications after laparoscopic gastric bypass occur in 5.8 to 12.4 % of patients. Recent studies identify prior abdominal surgeries, chronic liver diseases, arterial hypertension, chronic lung diseases, and repeated bariatric procedures as primary risk factors for postoperative complications.

Objective – to determine the primary risk factors associated with complications in obese patients after laparoscopic gastric bypass.

Materials and methods. A retrospective analysis was conducted on data from 556 obese patients, as defined by IFSO criteria, who underwent laparoscopic gastric bypass surgery between 2011 and 2025 at the Department of General Surgery No 2, Bogomolets National Medical University. Of these patients, 261 (46.3 %) were men and 295 (53.7 %) were women. The mean body weight was 151.88 (95 % CI: 135.5–168.1) kg, and the mean body mass index was 46.73 (95 % CI: 43.93–49.52) kg/m^2. The surgical and anesthetic risk, assessed using the ASA scale, was 3.42 (95 % CI: 3.31–3.53). Two groups of patients were established: a control group (2011–2019) and an experimental group (2019–2024), to evaluate the impact of the new strategy on the incidence of complications.

Results. Univariate logistic regression analysis identified seven factors with a significance level of < 0.1: duration of surgery, postoperative pain level, early mobilization, chronic obstructive pulmonary disease, gastroesophageal reflux disease, sleep apnea, and diabetes mellitus. To determine the minimum set of factorial features associated with the occurrence of complications in obese patients after laparoscopic gastric bypass, a multivariate logistic regression analysis was employed. This analysis identified five factorial features associated with complication risk: «duration of surgery», «postoperative pain level», «delayed mobilization», «sleep apnea syndrome», and «diabetes mellitus».

Conclusions. The factors influencing the development of postoperative complications in obese patients after laparoscopic gastric bypass surgery included the duration of surgery, postoperative pain level, delayed mobilization, sleep apnea syndrome, and diabetes mellitus.

Keywords
complications, gastric bypass, marginal ulcer, gastro-gastro fistula, Petersen's hernia, bleeding.

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Selecting appropriate surgical strategies for obese patients requires a multidisciplinary approach and individualized adaptation of established clinical protocols and recommendations. A key element in this process is the assessment of risk factors that may contribute to adverse outcomes or complications, as well as their timely diagnosis and management.

In 2007, E. J. DeMaria et al. developed a scale to assess the risk of negative outcomes after bariatric surgery, incorporating five main criteria: body mass index > 50 kg/m^2, male gender, arterial hypertension, risk factors for pulmonary thromboembolism, and age > 45 years [2]. Subsequent revisions expanded the scale to include additional risk factors and re-evaluated the original criteria. D. R. Flum et al. found that only a body mass index > 50 kg/m^2 was associated with increased rates of complications and mortality after bariatric surgery, with higher indices correlating directly with greater severity. The remaining four factors did not influence complication and mortality rates in this study [4].

U. K. Coblijn et al. (2016) applied this scale to obese patients undergoing laparoscopic gastric bypass. The criteria referenced above had no effect on the risk of death or complications. Repeated bariatric surgery was the only factor associated with an increased risk of complications or mortality [1].

Laparoscopic gastric bypass is considered among the most effective treatments for morbid obesity. According to the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) (8th Global Registry Report, 2023), 480,970 bariatric surgeries were performed in 2022, with laparoscopic gastric bypass accounting for 28.8 % of initial procedures [13].

Global data indicate that complications after laparoscopic gastric bypass occur in 5.8 to 12.4 % of patients [1].

Recent studies identify prior abdominal surgeries, chronic liver diseases, arterial hypertension, chronic lung diseases, and repeated bariatric procedures as primary risk factors for postoperative complications [7].

Objective – to determine the primary risk factors associated with complications in obese patients after laparoscopic gastric bypass.

Materials and methods

A retrospective analysis was conducted to identify risk factors associated with complications after laparoscopic gastric bypass. The study included 556 patients who underwent laparoscopic gastric bypass at the clinical base of the Department of General Surgery No 2, Bogomolets National Medical University between 2011 and 2025 (Table 1).

The observation period ranged from 6 to 65 months. The analysis focused exclusively on complications related to laparoscopic gastric bypass, including bleeding, marginal ulcers, suture failure, intestinal obstruction, and ineffective weight loss. All complications were classified using the Clavien-Dindo scale (Table 2).

Beginning in 2019, the management of obese patients before, during, and after laparoscopic gastric bypass was modified based on findings from our previous studies and the Enhanced Recovery After Surgery (ERAS) protocol. Consequently, two groups of patients were established: a control group (2011–2019) and an experimental group (2019–2024), to evaluate the impact of the new strategy on the incidence of complications.

According to the new strategy, preoperative preparation included catheterization of the epidural space and establishment of central venous access under ultrasound guidance. Additionally, saline laxatives and a carbohydrate mixture (5 % glucose, 200 ml) were administered 12 hours and 4 hours before surgery, respectively. Dexamethasone (8 mg) was administered intravenously 10 minutes before the incision, and antibiotic prophylaxis was provided 30 minutes before surgery. Intraoperatively, local infiltration anesthesia was given at the trocar insertion sites, and pneumatic compression of the lower extremities was used instead of elastic compression to prevent thrombosis. Cassettes for gastroenteroanastomosis and entero-enteric anastomosis were replaced, using the TriStaple technique. Paracetamol was administered intravenously at the beginning of the skin suturing procedure. At the conclusion of surgery, 5 ml of tranexamic acid was administered 12 and 24 hours after surgery. Postoperatively, the urinary catheter was removed immediately, the nasogastric tube was withdrawn within one day, and drains were removed 2–3 days after surgery. Early patient mobilization was implemented during the postoperative period. Oral fluid intake commenced 6 hours after surgery, with a stepwise increase in volume and a corresponding decrease in infusion therapy. On postoperative day 4, all patients without complications underwent contrast gastrography to assess the capacity of the gastroenteroanastomosis.

The study adhered to modern bioethical standards. Statistical analysis was performed using IBM SPSS Statistics Base software (version 26). Univariate and multivariate logistic regression models were applied. Results with $p < 0.05$ were considered statistically significant.

The results of univariate logistic regression models (Table 3) identified seven factors with a significance level < 0.1: duration of surgery, postoperative pain level, early mobilization, chronic obstructive pulmonary disease (COPD), gastroesophageal reflux disease (GERD), sleep apnea, and diabetes mellitus. To determine the minimum set of factorial features associated with the occurrence of complications in obese patients after laparoscopic gastric bypass, a multivariate logistic regression analysis was conducted. Five factorial features were found to be significantly associated with the probability of complications: «duration of surgery», «postoperative pain level», «delayed mobilization», «sleep apnea syndrome», and «diabetes mellitus» (Table 4).

A logistic regression model analysis identified the risk factors for bleeding, marginal ulcers, and intestinal obstruction in obese patients after laparoscopic gastric bypass. Arterial hypertension (OR = 1.78, CI: 1.03–3.04; $p = 0.05$), COPD (OR = 2.35, CI: 1.06–5.2; $p = 0.034$), and diabetes mellitus (OR = 17.26, CI: 3.72–80.1; $p < 0.001$)

Table 1. **Complications observed in obese patients after laparoscopic gastric bypass**

Complication	Number
Bleeding	14 (2.51 %)
Intraluminal	13 (2.33 %)
Intraperitoneal	1 (0.17 %)
Marginal ulcer complicated by	12 (1.07 %)
Perforation	1 (0.17 %)
Penetration	1 (0.17 %)
Bleeding with iron deficiency anemia	4 (0.71 %)
Uncomplicated	6 (1.07 %)
Ineffective weight loss	1 (0.17 %)
Strangulated hernia of Petersen's space	1 (0.17 %)
Gastro-gastro fistula	1 (0.17 %)
Splenic vein thrombosis with splenic infarction	1 (0.17 %)
Postoperative strangulated umbilical hernia	1 (0.17 %)
Acute adhesive small intestinal obstruction	1 (0.17 %)
Total	32 (5.75 %)

Table 2. **Classification of complications according to the Clavien-Dindo scale**

Degree	Number
I	0
II	12 (37.5 %)
IIIa	1 (3.1 %)
IIIb	19 (59.4 %)
IVa	0
IVb	0

were associated with an increased risk of postoperative bleeding. The use of NSAIDs (OR = 3.89, CI: 1.23–12.68; p < 0.001), diabetes mellitus (OR = 4.45, CI: 1.39–14.19; p < 0.001), and elevated postoperative pain levels (OR = 1.6, CI: 1.01–2.52; p < 0.001) were linked to a higher incidence of marginal ulcers. Additionally, duration of surgery (OR = 1.04, CI: 1.23–12.68; p < 0.001), diabetes mellitus (OR = 8.77, CI: 1.57–48.79; p < 0.001), delayed mobilization (OR = 1.9, CI: 1.01–2.6; p = 0.012), and sleep apnea syndrome (OR = 10.2, CI: 1.83–57.07; p = 0.008) were significant predictors of intestinal obstruction. Duration of surgery (OR = 1.03, CI: 1.00–1.07; p = 0.013), the presence of comorbid conditions (OR = 1.2, CI: 1.02–1.43; p = 0.028), arterial hypertension (OR = 1.56, CI: 1.03–2.35; p = 0.03), diabetes mellitus (OR = 4.03, CI: 1.5–10.81; p = 0.006), delayed mobilization (OR = 1.97, CI: 1.01–2.91; p < 0.001), and sleep apnea syndrome (OR = 2.8, CI: 1.00–7.86; p = 0.05) were all associated with an increased risk of early complications within 30 days after surgery.

The control group consisted of 178 patients treated between 2011 and 2019, including 86 (48.3 %) men and 92 (51.7 %) women. The mean body weight was 144.8 (95 % CI: 142.7–146.8) kg, and the mean body mass index (BMI) was 45.44 (95 % CI: 44.67–46.22) kg/m^2. The surgical and anesthetic risk, as measured by the ASA scale, was 3.36 (95 % CI: 3.25–3.47). The study group comprised 378 patients treated between 2019 and 2024. Both groups were comparable in terms of age, sex, height, body weight, BMI, and total number of participants. The overall incidence of postoperative complications was 23 cases (12.9 %) in the control group and 9 cases (2.38 %) in the experimental group. This reduction in complications was statistically significant (p < 0.05).

Discussion

Laparoscopic gastric bypass is one of the most effective methods for treating obesity and comorbid conditions associated with it. Timely identification of the principal risk factors minimizes the likelihood of complications after laparoscopic gastric bypass and provides a faster effect from the operation.

Since 2007, numerous risk assessment scales have been proposed to assess the risk of complications after laparoscopic gastric bypass. They are updated and improved annually with data from various bariatric centres.

The study identified several factors influencing the incidence of complications after laparoscopic gastric bypass: duration of surgery (OR = 1.06, CI: 1.02–1.1; p < 0.001), postoperative pain level (OR = 2.39, CI: 1.52–3.76; p < 0.001), delayed mobilization (OR = 1.99, CI: 1.02–2.95; p < 0.001), sleep apnea syndrome (OR = 4.23, CI: 1.45–12.34; p = 0.008), and diabetes mellitus (OR = 6.98, CI: 2.36–20.6; p < 0.001).

Prolonged duration of surgery is associated with an increased risk of complications. P. Major et al. (2016) confirmed this relationship, reporting a higher incidence of complications with longer procedures (OR = 1.01; CI: 1.00–1.02; p = 0.003)

Table 3. **Analysis of univariate logistic regression models for predicting bleeding in patients with morbid obesity during the postoperative period after laparoscopic gastric bypass**

Factor sign	Value of the coefficient of the model, b ± mb	Significance difference of the coefficient from 0, p	AUC (95 % CI)	Odds ratio indicator of the model, OR (95 % CI)	Significance difference of the OR from 0, p
Age, years	0.03 ± 0.02	0.067	0.59 (0.45–0.73)	1.03 (0.99–1.07)	0.067
Sex (1 – male, 2 – female)	0.35 ± 0.37	0.34	0.54 (0.44–0.64)	1.42 (0.68–2.93)	0.34
Weight, kg	0.008 ± 0.01	0.44	0.53 (0.44–0.62)	1.01 (0.98–1.03)	0.44
Height, cm	4.94 ± 2.03	0.015	0.5 (0.4–0.61)	140.4 (2.61–7542.65)	0.015
BMI, kg/m^2	0.01 ± 0.04	0.7	0.48 (0.39–0.57)	1.01 (0.94–1.09)	0.7
Time of operation, min	0.05 ± 0.01	0.001	0.74 (0.67–0.81)	1.05 (1.02–1.08)	0.001
ASA, class	0.34 ± 0.24	0.16	0.57 (0.47–0.66)	1.41 (0.87–2.29)	0.16
Number of comorbidities	0.15 ± 0.06	0.01	0.54 (0.43–0.65)	1.16 (1.02–1.32)	0.01
Chronic obstructive lung disease (1 – yes, 0 – no)	0.23 ± 0.16	0.1	0.57 (0.47–0.67)	1.26 (0.91–1.76)	0.1
Chronic liver disease (1 – yes, 0 – no)	–0.06 ± 0.18	0.74	0.46 (0.35–58)	0.94 (0.65–1.36)	0.74
Arterial hypertension (1 – yes, 0 – no)	0.07 ± 0.16	0.66	0.49 (0.38–0.6)	1.07 (0.77–1.49)	0.66
Diabetes mellitus (1 – yes, 0 – no)	1.54 ± 0.37	< 0.001	0.65 (0.55–0.766)	4.69 (0.2.25–9.77)	< 0.001
Alcohol consumption (1 – yes, 0 – no)	0.01 ± 0.55	0.97	0.5 (0.39–0.6)	1.01 (0.34–3.02)	0.97
GERD (1 – yes, 0 – no)	0.77 ± 0.4	0.05	0.57 (0.46–0.67)	2.16 (0.98–4.77)	0.05
Delayed mobilization (1 – yes, 0 – no)	3.28 ± 0.49	< 0.001	0.31 (0.2–0.42)	1.97 (1.91–2.06)	< 0.001
Myocardial infarction in anamnesis (1 – yes, 0 – no)	–0.32 ± 0.75	0.66	0.46 (0.38–0.59)	0.72(0.16–3.15)	0.66
Deep vein thrombosis (1 – yes, 0 – no)	–1.49 ± 1.02	0.14	0.45 (0.35–0.55)	0.22 (0.03–1.68)	0.14
Chronic venous insufficiency (1 – yes, 0 – no)	0.21 ± 0.36	0.56	0.52 (0.42–0.62)	1.23 (0.6–2.51)	0.56
Sleep apnea (1 – yes, 0 – no)	1.14 ± 0.38	0.003	0.6 (0.49–71)	3.14 (1.46–6.73)	0.003
Cholecystectomy during surgery (1 – yes, 0 – no)	–0.89 ± 0.46	0.25	0.41 (0.32–0.5)	0.4 (0.16–1.01)	0.25
Non-steroid anti-inflammatory drug (1 – yes, 0 – no)	0.81 ± 0.74	0.27	0.62 (0.53–0.71)	2.26 (0.52–9.8)	0.27
Level of discomfort after operation, points	0.55 ± 0.14	< 0.001	0.69 (0.6–0.78)	1.74 (1.3–2.32)	< 0.001

Table 4. **Multivariate logistic regression analysis of the development of postoperative complications in obese patients after laparoscopic gastric bypass**

Factor sign	Value of the coefficient of the model, b ± mb	Significance difference of the coefficient from 0, p	Odds ratio indicator of the model, OR (95 % CI)
Time of operation, min	0.06 ± 0.02	< 0.001	1.06 (1.02–1.1)
Level of discomfort after operation, points	0.87 ± 0.23	< 0.001	2.39 (1.52–3.76)
Delayed mobilization (1 – yes, 0 – no)	4.42 ± 0.8	< 0.001	1.99 (1.02–2.95)
Chronic obstructive lung disease (1 – yes, 0 – no)	0.43 ± 0.24	0.046	1.54 (0.95–2.48)
GERD (1 –yes, 0 – no)	1.29 ± 0.55	0.19	3.66 (1.23–10.85)
Sleep apnea (1 – yes, 0 – no)	1.44 ± 0.54	0.008	4.23 (1.45–12.34)
Diabetes mellitus (1 –yes, 0 – no)	1.94 ± 0.55	< 0.001	6.98 (2.36–20.6)

[5]. According to E. Stenberg (2014), the influence of operative time was significant when surgeons had performed fewer than 100 bariatric operations (OR = 1.83; CI: 1.47–2.07; p < 0.001). However, this effect was not observed when surgeons had completed more than 300 operations, and the operative time was less than 99.2 ± 45.63 [12].

Diabetes mellitus not only increases the overall complication rate but also elevates the risk of specific postoperative events, including postoperative bleeding (OR = 17.26, CI: 3.72–80.1; p < 0.001), marginal ulcers (OR = 4.45, CI: 1.39–14.19; p < 0.001), intestinal obstruction (OR = 8.77, CI: 1.57–48.79; p < 0.001), and early postoperative complications (OR = 4.03, CI: 1.5–10.81; p = 0.006). E. Stenberg (2014) reported that diabetes mellitus affects the occurrence of all complications (OR = 1.47, CI: 1.31–1.64; p < 0.001), but does not significantly influence the rate of serious complications (grade IIIB according to the Clavien-Dindo scale) – OR = 1.22, CI: 1.00–1.5; p = 0.053 [12]. The same results were observed in patients with and without diabetes mellitus, suggesting that diabetes mellitus may not independently affect the occurrence of complications [5, 11, 13].

Previous studies indicate that sleep apnea syndrome does not affect the rate of complications [3, 5]. However, further investigation of this issue is warranted.

Postoperative bleeding represents the most common complication after laparoscopic gastric bypass, prompting a separate analysis of risk factors in this population. The present data identify three factors associated with an increased risk of postoperative bleeding: arterial hypertension (OR = 1.78, CI: 1.03–3.04; p = 0.05), COPD (OR = 2.35, CI: 1.06–5.2; p = 0.034), and diabetes mellitus (OR = 17.26, CI: 3.72–80.1; p < 0.001). A meta-analysis by H. Santos-Sousa et al. (2024) involving 232,488 patients confirmed the association between arterial hypertension and postoperative bleeding (OR = 1.33, CI: 1.02–1.73; p < 0.01) [10]. Additional studies [7–9, 14] also demonstrated the influence of diabetes mellitus on postoperative bleeding. Currently, there is no evidence regarding the negative impact of chronic obstructive pulmonary disease on the occurrence of postoperative bleeding.

The adoption of a new patient management strategy contributed to a decrease in the number of complications from 23 (12.9 %) to 9 (2.3 %). The implementation of the ERAS protocol has been shown to reduce complication rates, length of hospital stay, and postoperative pain levels [6, 9]. In the study group, reduced postoperative pain and early mobilization likely contributed to the lower complication rate, consistent with the provisions of the ERAS protocol.

Conclusions

The factors influencing the development of postoperative complications in obese patients after laparoscopic gastric bypass surgery were identified. They include duration of surgery, postoperative pain level, delayed mobilization, sleep apnea syndrome, and diabetes mellitus.

The factors associated with postoperative bleeding in obese patients after laparoscopic gastric bypass surgery were identified. They include arterial hypertension, chronic obstructive pulmonary disease, and diabetes mellitus.

The factors influencing the development of postoperative complications in obese patients during the

early postoperative period after laparoscopic gastric bypass surgery were identified. These factors comprise duration of surgery, presence of several comorbid conditions, arterial hypertension, diabetes mellitus, delayed mobilization, and sleep apnea syndrome.

A new management strategy for obese patients after laparoscopic gastric bypass was developed, integrating the ERAS protocol and new elements identified by us based on previous studies. The application of the new strategy reduced the rate of postoperative complications from 12.9 % to 2.3 % ($p < 0.05$).

Declaration of interests

The authors, who participated in this study, stated that they had no conflicts of interest regarding this manuscript.

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Ethics approval and written informed consent statements

In this study, the authors adhered to the Ethical Principles for Medical Research Involving Human Subjects outlined in the World Medical Association Declaration of Helsinki and current Ukrainian regulations. The study protocol was approved by the ethics committee of Bogomolets National Medical University. Written informed consent was obtained from all the patients.

Authors contributions

Work concept and design, data collection and analysis, responsibility for statistical analysis – V. O. Nevmerzhytskyi, M. S. Kryvopustov; writing the manuscript, critical review – V. O. Nevmerzhytskyi.

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Аналіз чинників ризику ускладнень після лапароскопічного шунтування шлунка в пацієнтів з ожирінням

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За світовими даними, ускладнення після лапароскопічного шунтування шлунка виникають у 5,8—12,4 % пацієнтів. Згідно з останніми дослідженнями, загальними чинниками ризику післяопераційних ускладнень вважають наявність абдомінальних операцій в анамнезі, хронічні захворювання печінки, артеріальну гіпертензію, хронічні захворювання легень і повторні баріатричні операції.

Мета — визначити основні чинники ризику ускладнень у пацієнтів з ожирінням, яким проведено лапароскопічне шунтування шлунка.

Матеріали та методи. Проведено ретроспективний аналіз даних 556 пацієнтів з ожирінням відповідно до критеріїв IFSO, яким виконано лапароскопічне шунтування шлунка в період з 2011 до 2025 р. на базі кафедри загальної хірургії № 2 Національного медичного університету імені О. О. Богомольця. Серед них був 261 (46,3 %) чоловік і 295 (53,7 %) жінок. Середня маса тіла становила 151,88 (95 % довірчий інтервал (ДІ) — 135,5—168,1) кг, середній індекс маси тіла — 46,73 (95 % ДІ 43,93—49,52) кг/м^2. Хірургічний та анестезіологічний ризик за шкалою ASA — 3,42 (95 % ДІ 3,31—3,53).

Результати. За результатами однофакторних моделей логістичної регресії було відібрано 7 чинників із рівнем значущості < 0,1: тривалість операції, рівень болі після операції, рання активізація, хронічне обструктивне захворювання легень, гастроезофагеальна рефлюксна хвороба, нічне апное, цукровий діабет. Для відбору мінімального набору факторних ознак, пов'язаних із виникненням ускладнень у пацієнтів з ожирінням після лапароскопічного шунтування шлунка, використано метод багатофакторної логістичної регресії. Виділено 5 факторних ознак: «тривалість операції», «рівень болю після операції», «відсутність ранньої активізації», «синдром нічного апное» та «цукровий діабет».

Висновки. Визначено чинники впливу на розвиток післяопераційних ускладнень у пацієнтів з ожирінням після виконання лапароскопічного шунтування шлунка: тривалість операції, рівень болю після операції, відсутність ранньої активізації, синдром нічного апное та цукровий діабет.

Ключові слова: ускладнення, шунтування шлунка, маргінальна виразка, гастро-гастро нориця, грижа Петерсена, кровотеча.

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