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**ТИББИЁТДА ЯНГИ КУН
НОВЫЙ ДЕНЬ В МЕДИЦИНЕ
NEW DAY IN MEDICINE**

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МЕТОД ОПРЕДЕЛЕНИЯ КРИТЕРИЕВ ВЫБОРА БАРИАТРИЧЕСКИХ ОПЕРАЦИЙ У БОЛЬНЫХ С МЕТАБОЛИЧЕСКИМ СИНДРОМОМ

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✓ Резюме

Проведенный клинико-статистический анализ позволил обосновать рациональный подход к выбору метода бариатрического вмешательства у больных с метаболическим синдромом. Разработанная шкала, основанная на балльной оценке 8 ключевых параметров, включая показатели углеводного обмена, гормональной активности, морфометрические и анатомические особенности, продемонстрировала высокую прогностическую ценность и клиническую применимость

Ключевые слова: Метаболический синдром, бариатрия, прогнозирование

METABOLIK SINDROMLI BEMORLARDA BARIATRIK OPERATSIYALARNI TANLASH MEZONLARINI ANIQLASH USULI

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✓ Rezyume

O'tkazilgan klinik va statistik tahlil metabolik sindromli bemorlarda bariatrik aralashuv usulini tanlashga oqilona yondashishni asoslash imkonini berdi. Uglevod almashinuvi ko'rsatkichlari, gormonal faollik, morfometrik va anatomik xususiyatlarni o'z ichiga olgan 8 ta asosiy parametrlarni baholashga asoslangan ishlab chiqilgan shkala yuqori prognostik ahamiyatga ega va klinik qo'llanilishini ko'rsatdi.

Kalit so'zlar: Metabolik sindrom, bariatrik, vashoratlash

METHOD OF DETERMINING CRITERIA FOR SELECTION OF BARIATRIC SURGERY IN PATIENTS WITH METABOLIC SYNDROME

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✓ Resume

The conducted clinical and statistical analysis allowed us to substantiate a rational approach to choosing a method of bariatric intervention in patients with metabolic syndrome. The developed scale, based on a scoring of 8 key parameters, including carbohydrate metabolism indicators, hormonal activity, morphometric and anatomical features, demonstrated high prognostic value and clinical applicability

Keywords: Metabolic syndrome, bariatrics, prognosis

Relevance

To date, both international and domestic literature have accumulated substantial experience in evaluating the effectiveness of bariatric surgery (BS) in patients with morbid obesity and metabolic syndrome (MS). The main focus is on sleeve gastrectomy (SG) and Roux-en-Y gastric bypass (RYGB), which have proven to be effective methods of metabolic surgery (1,3,5,13).

Studies have confirmed that bariatric surgery can achieve remission of type 2 diabetes, normalize blood glucose levels, and improve lipid metabolism in the majority of patients. However, the effectiveness of the intervention directly depends on the patient's clinical and metabolic phenotype, which has prompted an active search for patient selection criteria and the personalization of surgical strategies (2,4,6,14).

A number of studies have shown that in cases of severe GERD, sleeve gastrectomy (SG) may exacerbate symptoms, whereas in patients with pronounced insulin resistance and long-standing type 2 diabetes, mini-gastric bypass (MGB) demonstrates a more significant hormonal effect. This has led to a reconsideration of the one-size-fits-all approach to surgical choice and to the justification for personalized surgical strategies (7,9,11,15).

There is active development in the field of surgical procedure modifications. For instance, variants of sleeve gastrectomy (SG) with an anti-reflux wrap and mini-gastric bypass (MGB) with an adapted pouch length and bypass limb have been proposed. However, to date, there are no unified criteria for the indications for these interventions, nor are there validated scales for assessing the clinical profile of patients (8,10).

A particular challenge is the lack of systematic data on the comparability of various surgical modifications, taking into account the severity of metabolic disorders and the morphometric parameters of the stomach. The insufficient standardization of indications for modified SG and MGB limits the widespread implementation of personalized algorithms in clinical practice (3,12).

Thus, despite the substantial number of publications devoted to bariatric surgery, the issue of selecting the appropriate surgical method for patients with metabolic syndrome (MS) remains insufficiently studied. To date, there are no universally accepted criteria for patient stratification, no clinically validated scale for determining the type of intervention, and the question of predicting surgical effectiveness based on metabolic and anatomical status remains unresolved.

All of the above has determined the main focus of this study.

Materials and methods

To identify diagnostically significant indicators that allow, at the preoperative stage, a high-probability determination of which surgical treatment method is most appropriate for a specific patient with metabolic syndrome (MS).

Given the objective of the present study—a comparative assessment of the effectiveness of standard and modified bariatric procedures in patients with metabolic syndrome (MS)—the surgical approach in the control and main groups differed in both technical and methodological aspects.

In the control group (n=107), formed during the first phase of the study (2018–2021), standard laparoscopic bariatric procedures were performed in accordance with current international protocols.

Two types of surgeries were used:

1. Laparoscopic sleeve gastrectomy (SG)
2. Laparoscopic mini-gastric bypass (MGB) was performed in a single-anastomosis configuration, with the creation of a 20 cm gastric pouch and a side-to-end gastroenterostomy with the small intestine at 200 cm from the ligament of Treitz.

The procedure was carried out without anatomical adaptation of the pouch to the morphometric features of the stomach and without individualization of the bypass limb length. Preoperative three-dimensional modeling was not performed.

The patients who received treatment and underwent examination in the Department of Surgery of the multidisciplinary clinic at the Tashkent Medical Academy from 2018 to 2021 (107 patients) comprised the control group.

A comprehensive clinical and laboratory assessment included anthropometric measurements, carbohydrate and lipid metabolism parameters, blood pressure, nutritional status, as well as instrumental diagnostics of GERD (esophagogastroduodenoscopy and pH-metry). The study

incorporated validated scales for assessing quality of life and surgical outcomes: BAROS-1, BAROS-2, BAROS-3, GIQLI, and EQ-5D. Special attention was given to a scoring questionnaire designed to evaluate early treatment outcomes, which was adapted to the structure of the dissertation research.

Outcome assessments were conducted at four time points in the immediate postoperative period (days 3, 7, 14, and 30) and at three follow-up points in the long-term period (3, 6, and 12 months). The results were interpreted with reference to clinical, biochemical, and behavioral markers of treatment effectiveness.

The applied research design and the multi-level evaluation system provided a reliable foundation for analyzing the clinical viability of a personalized surgical strategy.

Results and discussions

To identify clinical and laboratory parameters associated with the choice of bariatric surgery type, a comparative and correlation analysis was conducted using data from 107 patients in the control group. Potential predictors included indicators reflecting both the severity of metabolic disorders and the presence of GERD-related signs.

The correlation analysis revealed a number of parameters that were statistically significantly associated with the choice of bariatric procedure in patients with metabolic syndrome (MS).

The strongest negative correlation was found between the presence of GERD and the selection of mini-gastric bypass (MGB) ($r = -0.743$; $p < 0.05$). This indicates that the presence of clinically significant GERD reduced the likelihood of choosing MGB by more than threefold compared to patients without GERD.

This association was also evident in related indicators: extra-esophageal manifestations of GERD (such as chronic cough, hoarseness, non-cardiac chest pain, etc.) showed a correlation coefficient of $r = -0.509$ ($p < 0.001$), while GERD grade III or complicated forms were also significantly associated with rejection of bypass surgery ($r = -0.462$; $p < 0.05$).

In contrast, indicators reflecting the severity of metabolic disorders demonstrated a positive and moderately strong correlation with the choice of MGB. In particular, the HbA1c level had a correlation coefficient of $r = 0.576$ ($p < 0.001$), suggesting that for every 1% increase in HbA1c, the likelihood of selecting a bypass procedure increased by approximately 1.7 times. The HOMA-IR index showed the highest positive correlation ($r = 0.624$; $p < 0.001$); when HOMA-IR was ≥ 4.5 , the decision in favor of MGB was made 2–2.5 times more frequently than when the value was within the normal range.

Additional factors increasing the likelihood of performing MGB included: elevated BMI ($r = 0.486$; $p = 0.004$), longer duration of type 2 diabetes ($r = 0.407$; $p = 0.011$), and the need for insulin therapy ($r = 0.437$; $p = 0.007$). Specifically, patients with a BMI over 48 kg/m² were 1.8 times more likely to undergo MGB than those with a BMI under 42 kg/m². The use of insulin, as a marker of severe metabolic refractoriness, nearly doubled the likelihood of bypass surgery compared to patients who managed glycemia with metformin alone. Moreover, the presence of hepatic steatosis, confirmed by ultrasound or CT, also showed a statistically significant—though less pronounced—positive correlation with the choice of MGB ($r = 0.384$; $p = 0.016$) in the control group. This may be due to the fact that fatty liver infiltration is often associated with severe insulin resistance, reinforcing the rationale for choosing a hormonally active surgical approach.

Thus, the analysis demonstrated that patients with predominant GERD symptoms, particularly in its complicated forms, are more likely to undergo sleeve gastrectomy (SG). In contrast, patients with significant disturbances in carbohydrate metabolism, high BMI, and signs of hormonal refractoriness are more frequently candidates for mini-gastric bypass (MGB).

The results of the ROC analysis allowed for a quantitative assessment of the diagnostic value of individual clinical and laboratory indicators in the context of selecting the type of bariatric intervention in patients with metabolic syndrome (MS). The highest area under the curve (AUC = 0.912; $p < 0.001$) was demonstrated by the presence of GERD, indicating its exceptionally high discriminative power in determining indications for sleeve gastrectomy (SG). The sensitivity and specificity of this indicator were 87.0% and 82.1%, respectively, meaning that in the presence of GERD, the likelihood of SG being indicated was more than 4 to 1 compared to patients without this condition.

Among the quantitative indicators, HOMA-IR showed the highest predictive power (AUC = 0.877; $p < 0.001$). A threshold value of ≥ 4.5 provided a sensitivity of 81.2% and specificity of 78.8% in favor of mini-gastric bypass (MGB). Overall, exceeding this threshold increased the probability of undergoing a bypass procedure by more than threefold. A similar level of diagnostic accuracy was observed for HbA1c levels: at a threshold value of $\geq 6.8\%$, the AUC was 0.846 ($p < 0.001$), with sensitivity and specificity of 79.4% and 76.2%, respectively. These parameters reflect the metabolic activity of the disease and the degree of its resistance to medical therapy.

BMI also had additional predictive value, with an optimal cut-off of ≥ 45 kg/m² (AUC = 0.801; $p = 0.002$). Patients with a BMI above this threshold were 2–2.5 times more likely to undergo MGB. Similarly, the use of insulin therapy (AUC = 0.768; $p = 0.004$) and a duration of type 2 diabetes longer than 5 years (AUC = 0.741; $p = 0.011$) showed moderate but consistent predictive significance. The indicator “Grade III GERD” (AUC = 0.782) further confirmed the importance of complicated reflux as a factor directly associated with the frequency of SG procedures performed.

Thus, the ROC analysis confirmed the high predictive value of several clinical and laboratory parameters that make it possible to preoperatively determine the optimal type of surgical intervention. Based on the obtained data, it became possible to develop a unified scoring system that can serve as a clinical decision-making tool in planning bariatric surgery for patients with metabolic syndrome (MS).

A visual distribution of patients according to key diagnostic indicators was presented as a three-dimensional diagram, illustrating the type of recommended intervention. Patients for whom sleeve gastrectomy (SG) was indicated are marked in green, while those recommended for mini-gastric bypass (MGB) are marked in red. The diagram clearly shows the clustering of patients based on metabolic and anatomical criteria that determine the choice of surgical method.

The diagram vividly demonstrates the spatial separation between the two patient groups. Most patients with high HOMA-IR and HbA1c levels but without signs of GERD are located in the “upper zone” of the graph (high values along the X and Y axes, low values along the Z axis), corresponding to the choice of MGB. In contrast, patients with GERD ($Z = 1$), but with less pronounced metabolic disturbances, are concentrated in the “lower zone” and predominantly assigned to the SG group. This distribution confirms the reliability of the identified predictors and the validity of the proposed scoring system.

This graph not only visually verifies the results of the ROC analysis and correlation calculations but also allows for an additional assessment of the strength of feature clustering within the clinical decision space, thereby reinforcing the justification for the proposed algorithm for choosing the type of bariatric surgery.

Overall, the clinical and statistical analysis conducted allowed us to justify a rational approach to the selection of bariatric intervention in patients with MS. Based on this, we developed a scoring system that evaluates eight key parameters, including indicators of carbohydrate metabolism, hormonal activity, and morphometric and anatomical characteristics.

Patients with a total score ranging from 0 to 39 are characterized by a relatively balanced metabolic profile and no signs of clinically significant GERD. Typically, these are individuals with a BMI below 42 kg/m², HbA1c levels under 6.8%, HOMA-IR less than 3.5, a type 2 diabetes duration of less than 3 years, normal C-peptide levels (>2.0 ng/mL), not requiring insulin therapy, and without complaints of heartburn, regurgitation, or retrosternal pain. In this group, the choice of bariatric procedure may be determined by the technical capabilities of the clinic or the surgeon’s preferences, as the expected effect in terms of metabolic compensation and weight control would be similar with both sleeve gastrectomy (SG) and mini-gastric bypass (MGB). Nonetheless, from a practical standpoint, SG in its standard form may be preferred due to its relative technical simplicity.

Thus, as demonstrated in this clinical case, both types of bariatric procedures (SG and MGB) are clinically acceptable, and the choice of surgery may depend on available equipment, as well as the preferences of the patient and the physician. In settings where access to bypass surgery is limited, SG may be favored.

A total score in the range of 40 to 60 is more commonly observed in patients with pronounced GERD combined with moderate manifestations of metabolic syndrome. These are patients with a BMI between 42 and 48 kg/m², HbA1c levels ranging from 6.8% to 7.5%, HOMA-IR not exceeding 5.0, type 2 diabetes duration of less than 5 years, normal or borderline C-peptide levels, and receiving oral

therapy without insulin. Most of these patients present with gastric or extra-gastric forms of GERD, and in some cases, with GERD of grade II–III. SG is indicated for such patients.

Patients with a total score of ≥ 60 display pronounced signs of metabolic decompensation, including high HbA1c levels ($>7.5\%$), HOMA-IR ≥ 5.0 , BMI above 48 kg/m^2 , low C-peptide levels ($<1.0 \text{ ng/mL}$), a long history of type 2 diabetes (>5 years), and a need for insulin therapy. In these cases, GERD is either absent or well-controlled with basic therapy. These patients are indicated for MGB, which is the most effective method of metabolic correction. Due to the anatomical specifics of the procedure (a suspended gastric pouch and exclusion of the duodenum and proximal small intestine), it produces a strong hormonal and neuroendocrine effect without increasing the risk of reflux. Clinical experience shows that in this category of patients, MGB ensures rapid and sustained weight loss, type 2 diabetes remission, and improvement in the lipid profile in a short period.

It is important to emphasize that the developed scoring system not only provides a rationale for choosing between the two main types of bariatric procedures in patients with MS, but also serves as a starting point for further personalization of surgical strategy. In particular, among patients with predominantly severe metabolic disorders and indications for MGB, there arises a need to adapt the extent of the intervention to the individual anatomical and functional characteristics of the stomach.

This approach is implemented through preoperative three-dimensional modeling of the upper gastrointestinal tract, followed by the calculation of the optimal length of the gastric pouch and the bypass limb. The data presented in Table 3 illustrate the developed principle of integrating stomach morphometric parameters with the severity of metabolic disorders to personalize the volume of mini-gastric bypass (MGB).

The basis for constructing the algorithm was the results of three-dimensional gastric modeling (assessment of gastric volume and the length of the lesser curvature), along with the total score calculated using the surgical decision-making scale.

In patients with a gastric volume of less than 300 mL and moderate severity of metabolic disorders (total score 40–49), the optimal configuration includes a short pouch 18 cm in length and a bypass limb of 150 to 180 cm. This provides the necessary hormonal effect without the risk of overcorrection or excessive malabsorption.

For patients with a gastric volume between 300 and 450 mL and a score of 50–59, a 20 cm pouch and a 180–200 cm bypass limb are recommended, ensuring a physiological transit volume with sufficient metabolic impact.

In patients with a large stomach (volume $>450 \text{ mL}$) and the highest total score (≥ 60), it is advisable to lengthen the pouch to 22 cm and extend the bypass limb to 220 cm. In this group, the severity of metabolic disorders requires a maximal hormonal response, while the increased gastric volume allows for safe creation of a longer pouch without the risk of narrowing or functional instability.

Thus, the clinical and statistical analysis conducted has provided a sound rationale for a tailored approach to selecting bariatric surgery methods in patients with metabolic syndrome. The developed scoring system—based on eight key parameters, including markers of carbohydrate metabolism, hormonal activity, and anatomical and morphometric features—has demonstrated high predictive value and clinical applicability. The most discriminative factors identified through ROC analysis were HOMA-IR, HbA1c, and the presence of GERD.

These findings are particularly significant in the context of personalized surgical strategies. In patients for whom MGB is indicated according to the scale, there is a clear need to adapt the procedure's volume to individual anatomical features. Therefore, based on stomach volume determined through 3D modeling and the total score on the decision-making scale, an algorithm was developed for selecting the appropriate length of the gastric pouch and bypass limb.

This formalized system for selecting both the type and parameters of the surgical procedure not only enhances the rationale behind clinical decision-making but also lays the foundation for standardized personalized surgery. In turn, this contributes to reducing the risk of tactical errors, minimizing complications, and increasing the likelihood of achieving complete metabolic remission.

Conclusion

1. The formalized system for selecting the type of surgery and its parameters not only enhances the rationale behind clinical decision-making but also lays the foundation for the transition to standardized personalized surgery.

2. The developed scoring system—based on the assessment of 8 key parameters, including indicators of carbohydrate metabolism, hormonal activity, and morphometric and anatomical features—demonstrated high predictive value and clinical applicability. The most discriminative indicators in the ROC analysis were HOMA-IR, HbA1c, and the presence of GERD.
3. In patients for whom the scoring system indicates mini-gastric bypass (MGB), it is necessary to adapt the volume of the intervention to individual anatomy. Based on gastric volume (determined via 3D modeling) and the total score, an algorithm was developed to determine the optimal length of the gastric pouch and the bypass limb.

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