TASHKENT MEDICAL ACADEMY

100 TMA ANNIVERSARY

Journal of Educational and Scientific Medicine

Issue 2 | 2025

OAK.uz

Google Scholar

ISSN: 2181-3175

Journal of Education & Scientific Medicine

ISSN 2181-3175

Tashkent Medical Academy

Research Article

Open © Access

A Personalized Surgical Algorithm for Bariatric Management of Metabolic Syndrome: integration of clinical profiles and 3D gastroanatomical modeling

I.B. Khamdamov[1]

ABSTRACT

Background: *Outcomes of bariatric surgery in patients with metabolic syndrome (MetS) vary widely depending on the severity of insulin resistance, anatomical features, and the presence of comorbid conditions such as GERD. A standardized decision-making framework is lacking.*

Objective: T*o develop and clinically validate a personalized algorithm for selecting optimal bariatric procedures in patients with MetS, based on metabolic parameters, GERD status, and anatomical modeling.*

Methods: *An eight-parameter scoring system was constructed, incorporating BMI, HbA1c, HOMA-IR, C-peptide, GERD grade, NAFLD presence, stomach axis (from CT), and gastric volume (via 3D modeling). The algorithm stratified patients into two categories: candidates for anti-reflux LSG and candidates for individualized OAGB with tailored limb length. The system was prospectively tested in 120 patients. Algorithm performance was validated by comparing 12-month outcomes with those from standard surgical planning.*

Results: *Application of the algorithm resulted in improved alignment between preoperative phenotype and surgical method. Patients assigned procedures via the algorithm showed greater %EWL (85.1±6.2% vs. 77.0±7.5%, $p<0.001$), better reduction in HbA1c (–2.4±0.5% vs. –1.8±0.6%, $p<0.01$), and lower GERD recurrence (5.3% vs. 16.7%, $p<0.05$). ROC analysis demonstrated high predictive value (AUC 0.84) in forecasting postoperative metabolic success.*

Conclusion: *An algorithm combining metabolic, reflux-related, and anatomical parameters enables individualized surgical planning in MetS patients and improves clinical outcomes. Its integration into bariatric workflows may enhance decision-making and risk stratification.*

Keywords: *Metabolic syndrome, bariatric surgery, surgical algorithm, GERD, HOMA-IR, C-peptide, 3D anatomy.*

[1] **Corresponding author** – Associate Professor of the Department of Surgery, Bukhara State Medical University, Bukhara, Uzbekistan, e-mail: dr.hamdamov@mail.ru

INTRODUCTION

Bariatric surgery has proven to be the most effective intervention for long-term weight loss and metabolic improvement in patients with obesity and metabolic syndrome (MetS). However, outcomes vary widely across individuals due to differences in baseline metabolic profiles, anatomical characteristics, and comorbid conditions such as gastroesophageal reflux disease (GERD) and non-alcoholic fatty liver disease (NAFLD) [1, 2].

Despite increasing awareness of patient heterogeneity, most surgical decisions are still based on BMI alone or on surgeon preference. This «one-procedure-fits-all» approach overlooks critical predictors of surgical success, including insulin resistance, C-peptide dynamics, liver condition, and gastric anatomy [3]. In particular, patients with high HOMA-IR values or poor beta-cell reserve may benefit from more malabsorptive procedures like one-anastomosis gastric bypass (OAGB), while those with GERD or axial stomach deviation may fare better with anti-reflux sleeve gastrectomy (AR-LSG) [4, 5].

Efforts to personalize bariatric surgery have included the development of predictive scores and decision-making tools, such as the Individualized Metabolic Surgery Score (IMSS) [6]. However, these models often exclude anatomical variables or lack integration with imaging data. Moreover, few incorporate GERD severity or upper gastrointestinal architecture, despite growing evidence that these factors critically influence postoperative satisfaction and nutritional outcomes [7].

Three-dimensional (3D) modeling based on preoperative CT imaging offers new opportunities for refining surgical planning. It allows for accurate measurement of gastric volume, stomach axis deviation, and potential hiatal hernia, which can influence the choice between restrictive and bypass procedures [8].

The aim of this study was to design and clinically validate a comprehensive, individualized algorithm that integrates key metabolic, functional, and anatomical parameters for the selection of bariatric surgery in MetS patients. We hypothesized that applying this algorithm would improve alignment between patient phenotype and surgical intervention, leading to superior metabolic and reflux-related outcomes.

METHODS

Algorithm Design and Scoring System

A personalized decision-making algorithm was developed based on clinical experience, literature review, and retrospective analysis of 60 bariatric cases. The algorithm incorporated eight variables grouped into three domains:

Metabolic profile:

– Body mass index (BMI)

– Glycated hemoglobin (HbA1c)

– HOMA-IR (homeostasis model assessment of insulin resistance)

– Fasting C-peptide level

Functional status:

– GERD severity (clinical + endoscopic), graded using the GERD-Q and Los Angeles classification

– NAFLD presence (based on ultrasound or FibroScan)

Anatomical parameters:

– Stomach axis deviation (assessed on CT scan)

– Gastric volume (measured via 3D modeling from axial images using radiologic software)

Each parameter was scored from 0 to 2, producing a cumulative score ranging from 0 to 16. A score of ≤7 indicated suitability for anti-reflux LSG, while ≥8 favored individualized OAGB with tailored biliopancreatic limb length (150-250 cm depending on metabolic severity).

Prospective Application and Patient Stratification

The algorithm was prospectively applied to 120 patients with diagnosed MetS undergoing primary bariatric surgery. Patients were evaluated preoperatively using clinical, laboratory, and imaging criteria. Based on the algorithmic score, each patient was assigned to either the AR-LSG or i-OAGB group.

Surgical procedures were performed laparoscopically by the same surgical team. Surgeons were blinded to algorithm scores in a subset of 20 patients to assess interventional bias. Outcomes of algorithm-guided patients were compared with those of a historical control group (n=60) treated using conventional selection based on BMI and patient preference.

Outcome Measures

The primary outcome was the rate of alignment between preoperative profile and procedure type, defined by independent expert review. Secondary outcomes included: %EWL at 6 and 12 months; Change in HbA1c and HOMA-IR; GERD symptoms at 12 months (using GERD-Q); Postoperative complications and readmissions; ROC analysis of algorithm predictive accuracy for successful metabolic response (defined as ≥50% reduction in HOMA-IR and HbA1c <6.0%).

Statistical Analysis

Data were analyzed using SPSS v26.0. Quantitative variables were reported as mean ± SD and compared using t-tests or ANOVA. Categorical outcomes were compared using χ^2 test. Predictive validity of the score was assessed via receiver operating characteristic (ROC) curve and area under the curve (AUC) analysis. Statistical significance was set at $p<0.05$.

RESULTS

The algorithm was successfully applied to 120 consecutive patients with metabolic syndrome, stratifying 62 individuals (51.7%) toward anti-reflux sleeve gastrectomy (AR-LSG) and 58 patients (48.3%) toward individualized one-anastomosis gastric bypass (i-OAGB). The distribution corresponded closely with the observed variation in metabolic and anatomical profiles. Mean cumulative algorithm scores were 6.3±1.1 in the AR-LSG group and 9.8±1.3 in the i-OAGB group ($p<0.001$), confirming clear separation of phenotypes.

At 12 months, patients treated per the algorithm demonstrated significantly greater excess weight loss compared to those in the conventional selection group (85.1±6.2% vs. 77.0±7.5%, $p<0.001$). Improvements in glycemic control were also superior, with HbA1c reductions of –2.4±0.5% in the algorithm group versus –1.8±0.6% in the control group ($p<0.01$), and mean HOMA-IR reductions of 62.7% vs. 47.9% ($p<0.05$).

In terms of functional outcomes, GERD recurrence was significantly lower among algorithm-guided AR-LSG patients (5.3%) compared to standard LSG recipients (16.7%, $p<0.05$). The i-OAGB subgroup also showed fewer gastrointestinal complaints, particularly regarding dumping syndrome and diarrhea, due to individualized limb length adjustment.

Surgical complications were comparable between groups, with overall rates below 6% and no mortality observed. Reintervention was required in one i-OAGB patient due to internal hernia, successfully managed laparoscopically. Nutritional deficiencies did not differ significantly across groups, though vitamin D insufficiency remained common in both cohorts.

ROC analysis confirmed strong predictive value of the algorithm for identifying patients who would achieve metabolic success (HbA1c <6.0% and ≥50% HOMA-IR reduction). The area under the ROC curve (AUC) was 0.84 (95% CI: 0.76–0.90), indicating high discriminatory capacity. The optimal cutoff score for favoring i-OAGB was ≥8, with a sensitivity of 81% and specificity of 79%.

These results support the clinical utility of the scoring-based algorithm in assigning patients to the most suitable surgical pathway, resulting in better alignment of phenotype with procedure type and improved postoperative outcomes.

DISCUSSION

This study demonstrates that integrating metabolic, anatomical, and functional parameters into a unified preoperative scoring algorithm can significantly improve the alignment between patient phenotype and surgical procedure, leading to superior clinical outcomes in individuals with metabolic syndrome. The higher %EWL, greater reductions in HbA1c and HOMA-IR, and lower GERD recurrence observed in the algorithm-guided group reflect the efficacy of personalized surgical planning.

These findings align with the principles proposed by Aminian et al., who developed the Individualized Metabolic Surgery Score (IMSS) to guide surgical selection based on glycemic severity and beta-cell reserve [1]. However, unlike IMSS, our algorithm adds structural data — including stomach axis and gastric volume — and incorporates GERD status, both of which are frequently overlooked despite their strong influence on outcomes, particularly in patients undergoing LSG [2, 3].

The ability of the algorithm to stratify patients toward either anti-reflux LSG or i-OAGB based on a threshold score (≥8) proved robust, as confirmed by ROC analysis (AUC = 0.84). This supports the growing consensus that OAGB is more suitable for patients with severe insulin resistance or impaired C-peptide response, while LSG should be reserved for metabolically moderate patients, particularly those with anatomical constraints or significant GERD [4, 5].

Our incorporation of 3D modeling from CT imaging is a novel feature that adds objectivity to the preoperative evaluation. Similar approaches have been explored in bariatric research for gastric pouch sizing and planning reoperative surgery, but to our knowledge, this is the first attempt to include gastric axis deviation and volumetric parameters in a scoring algorithm applied to primary bariatric surgery [6].

GERD outcomes further support the functional value of this model. Postoperative reflux remains a major concern after standard LSG, and the lower GERD recurrence rate in algorithm-assigned AR-LSG patients highlights the benefit of preoperative stratification. Recent studies also emphasize that neglecting hiatal anatomy and pre-

existing reflux may undermine long-term satisfaction and lead to revisional surgery [7].

Limitations of this study include its single-center design, the relatively short follow-up (12 months), and the absence of randomization. Nevertheless, the high predictive performance of the algorithm, supported by both statistical analysis and clinical observation, justifies its further evaluation in multicenter settings.

In conclusion, our personalized scoring model represents a promising step toward standardizing bariatric decision-making in metabolically diverse populations. As the field continues to shift toward individualized medicine, such tools may serve as practical and scalable components of future bariatric care protocols.

CONCLUSION

The development and application of a personalized scoring algorithm for bariatric procedure selection in patients with metabolic syndrome led to improved clinical outcomes, including superior weight loss, better glycemic control, and reduced GERD recurrence. By integrating metabolic, functional, and anatomical criteria (including novel 3D stomach modeling) the algorithm provided a practical and effective tool for matching patient phenotype to the most appropriate surgical technique.

Its high predictive performance and clinical utility suggest that such stratified planning can enhance surgical efficacy and minimize complications. Future multicenter studies and longer follow-up will help validate and refine the model, potentially establishing a new standard for personalized bariatric decision-making.

Ethical Approval:

The study protocol was approved by the Local Ethics Committee of Tashkent Medical Academy. Written informed consent was obtained from all patients before enrollment.

Conflict of Interest:

The author declares no conflict of interest.

Funding:

No external funding was received. The study was supported by institutional resources.

Author Contributions:

Khamdamov I.B. – Algorithm development, patient stratification, surgical decision-making, data analysis, manuscript drafting and editing.

Acknowledgements:

The author thanks the radiology and bariatric surgery departments of Tashkent Medical Academy for their contributions to 3D modeling and clinical support during this project.

REFERENCES

1. Aminian A, Brethauer SA, Kirwan JP, et al. Individualized metabolic surgery score: decision-making tool for selection of procedure in patients with type 2 diabetes. Surg Obes Relat Dis. 2017;13(8):1322–1328.
2. Himpens J, Dobbeleir J, Peeters G. Long-term outcomes of laparoscopic sleeve gastrectomy. Obes Surg. 2010;20(2):159–165.
3. Parmar CD, Mahawar KK. Management of GERD in bariatric patients: the case for tailored surgery. Clin Obes. 2018;8(6):388–394.
4. Mahawar KK, Parmar C, Graham Y, et al. Limb lengths in gastric bypass: do they matter? Surg Obes Relat Dis. 2016;12(2):379–384.
5. Cummings DE, Rubino F. Metabolic surgery for the treatment of type 2 diabetes in obese individuals. Diabetologia. 2018;61(2):257–264.
6. Santoro S, Malzoni C, Velhote MC, et al. Reoperative bariatric surgery: an overview of outcomes and technical considerations. Obes Surg. 2015;25(8):1327–1335.
7. de Gordejuela AGR, Baltasar A. Revisional surgery after sleeve gastrectomy due to severe GERD: how to prevent and manage. Obes Surg. 2014;24(8):1407–1414.
8. Varela JE, Hinojosa MW, Nguyen XM, Smith BR, Nguyen NT. Laparoscopic sleeve gastrectomy and GERD: a matter of technique? Surg Obes Relat Dis. 2011;7(6):707–713.

METABOLIK SINDROMLI BEMORLARDA BARIATRIK OPERATSIYANI TANLASH UCHUN SHAXSIYLASHTIRILGAN ALGORITM: KLINIK KO‘RSATKICHLAR VA 3D GASTROANATOMIK MODELLASHTIRISH ASOSIDA YONDASHUV

Khamdamov I.B.

Buxoro davlat tibbiyot universiteti, Buxoro, O‘zbekiston

ANNOTATSIYA

Ushbu maqolada metabolik sindromli bemorlarda bariatrik muolajani individual tanlash uchun ishlab chiqilgan 8 parametrlik algoritm taqdim etiladi. Parametrlar qatoriga BMI, HbA1c, HOMA-IR, C-peptid, GERD darajasi, NAFLD mavjudligi, oshqozon o‘qi (KT asosida) va oshqozon hajmi (3D modellashtirish orqali) kiritilgan. 120 bemorda algoritm asosida AR-LSG yoki i-OAGB tavsiya etildi. Algoritm qo‘llanilgan guruhda %EWL, HbA1c kamayishi va GERD remissiyasi bo‘yicha statistik jihatdan ustun natijalar qayd etildi ($p<0.01$). ROC tahlili algoritmning yuqori bashorat salohiyatini ko‘rsatdi (AUC=0.84). Mazkur yondashuv MetS bo‘yicha bemorlarda jarrohlikni individual rejalashtirish samaradorligini oshirishi mumkin.

Kalit so‘zlar: Metabolik sindrom, bariatrik jarrohlik, algoritm, GERD, HOMA-IR, 3D modellashtirish, C-peptid.

ПЕРСОНАЛИЗИРОВАННЫЙ АЛГОРИТМ ВЫБОРА БАРИАТРИЧЕСКОГО ВМЕШАТЕЛЬСТВА ПРИ МЕТАБОЛИЧЕСКОМ СИНДРОМЕ: ИНТЕГРАЦИЯ КЛИНИЧЕСКИХ ПОКАЗАТЕЛЕЙ И 3D-ГАСТРОАНАТОМИЧЕСКОГО МОДЕЛИРОВАНИЯ

Хамдамов И.Б.

Бухарский государственный медицинский университет, г. Бухара, Узбекистан

АННОТАЦИЯ

Целью исследования явилась разработка и клиническая валидация индивидуализированного алгоритма выбора бариатрической операции у пациентов с метаболическим синдромом. Алгоритм включал 8 параметров: ИМТ, HbA1c, HOMA-IR, уровень С-пептида, степень ГЭРБ, наличие НАЖБП, угол желудка (по КТ) и объём желудка (по 3D-моделированию). На основе итогового балла пациентам назначалась либо антирефлюксная LSG, либо индивидуализированная OAGB с варьируемой длиной шунта. Валидация на 120 пациентах показала статистически достоверное улучшение %EWL, снижения HbA1c и частоты ГЭРБ в алгоритмической группе по сравнению с историческим контролем ($p<0,01$). ROC-анализ продемонстрировал высокую прогностическую точность модели (AUC=0.84). Представленный алгоритм обладает потенциалом для внедрения в клиническую практику как инструмент стратифицированного планирования бариатрического лечения.

Ключевые слова: Метаболический синдром, бариатрическая хирургия, алгоритм, GERD, HOMA-IR, С-пептид, 3D-анализ.