

# Prediction of the Risk of Recurrence of Anterior Abdominal Wall Hernias in Elderly and Senile Patients

Zuhurov Sukhrob Elmurotovich\*, Khamdamov Bakhtiyor Zarifovich

Bukhara Medical Institute, Uzbekistan

**Abstract** Logistic analysis allowed us to reliably identify the most significant independent risk factors that must be taken into account when forming a prognostic model and a stratification algorithm for choosing the optimal laparoscopic tactics. Taking into account the data obtained as a result of multifactorial logistic analysis, a system for stratifying patients according to the degree of risk of recurrent hernia after laparoscopic intervention was formed.

**Keywords** Anterior abdominal wall hernia, Recurrence, Complications, Risk

## 1. Introduction

The development of abdominal hernias is a complex pathological process, resulting from the interaction of a number of etiological factors and pathogenetic mechanisms. Some of these factors and mechanisms are considered to be common for the development of hernias and some andrological diseases. According to S. Ravanbakhsh (2015), factors such as decreased body mass index, old age, male gender, Caucasian race, family history of hernias, smoking, alcoholism, high comorbidity index, increase the likelihood of inguinal hernias, and obesity is a risk factor for complications [1,2,3,4,19]. O. I. Usenko et al. (2015) believe that obesity is the main cause of morphofunctional insufficiency of muscular-aponeurotic structures [2,5,7,9,11,13,15]. With obesity, not only does intra-abdominal pressure increase, but also the activity of the sympathetic nervous system increases, affecting the endocrine status (the level of testosterone decreases), which leads to inflammation and peroxidation, as well as to insulin resistance and impaired secretion of adipokines.

The frequency of recurrent abdominal wall hernias in patients remains high, despite significant progress in surgical treatment technologies over the past decades. The development of laparoscopic technologies in hernia surgery has led to a decrease in tissue trauma, improved early postoperative results and a decrease in hospital mortality, but the problem of recurrence remains unresolved in full [2,8,10,12,14,16,17]. Recurrent hernias in patients are characterized by more pronounced morphological changes in the area of the hernial orifice, loss of elasticity and strength of aponeurotic structures, as well as the presence of

a pronounced adhesion process in the abdominal cavity [16,18,19]. These features significantly complicate both primary and repeated laparoscopic interventions, increasing the risk of intraoperative injuries and postoperative complications.

Clinicians also point out the increased risks associated with anesthetic management and postoperative care of older patients. Patients with PWS have a high risk of cardiopulmonary complications, blood clotting disorders, and infectious complications, which requires a special approach to the choice of surgical tactics, implant fixation techniques, and postoperative monitoring strategies [2,5,19]. Despite the development of laparoscopic herniotomy technologies and the introduction of modern implants, the problem of optimizing the results of operations in patients with PWS with recurrent hernias of the PBS remains relevant and requires further solutions based on a comprehensive analysis of risk factors, features of the disease course, and modification of surgical tactics [5]. Modern aspects of the development of domestic medicine include many measures aimed at improving the results of treatment of patients, including those with recurrent hernias of the elderly and senile age (PBS).

**The aim of the study:** to determine the clinical, anatomical, functional and technical parameters that increase the risk of complications and relapse, with the aim of their subsequent inclusion in the algorithm of personalized surgical treatment tactics.

## 2. Materials and Methods

Taking into account the clinical and anatomical specificity of recurrent hernias in older patients identified in the previous sections, this part of the study is devoted to the formation of personalized tactics of laparoscopic treatment. The development of an optimized approach was based on

\* Corresponding author:

yakkashoh@mail.ru (Zuhurov Sukhrob Elmurotovich)

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an objective assessment of anatomical, morphometric and functional parameters associated with a high risk of unfavorable outcome. First of all, the main anatomical changes that can reduce the effectiveness of standard laparoscopic techniques were analyzed. These include: DPM, disrupting the tension axis of the aponeurosis and stabilization of the implant; thinning of the aponeurosis, weakening the holding capacity of the tissues; ptosis of the ASP, changing the configuration of intra-abdominal pressure; grade III-IV SP, limiting the working space and increasing the risk of injury; as well as large hernial defects (diameter > 10 cm or area > 100 cm<sup>2</sup>), requiring special fixation and non-standard implants.

Two subgroups were identified for the analysis: patients whose postoperative course was complicated by one or more adverse events (n=37) and patients with a satisfactory postoperative course without complications (n=52). The comparison took into account: morphometric parameters of the hernial defect, severity of the adhesion process, presence of anatomical changes (hernial hernia, thinning of the aponeurosis), features of previously performed operations, somatic status according to the ASA and Charlson scales, as well as the presence or absence of an implant in the previous GP.

### 3. Results and Discussion

The results of the analysis showed that all the studied parameters had statistically significant differences between the groups, which confirms their prognostic significance. The age of patients with complications was higher (72.3±4.8 years versus 69.1±5.4; p<0.01), which indicates age as an independent risk factor reflecting not only biological wear of tissues, but also a decrease in adaptive capabilities and regenerative potential.

The key anatomical risk factor was the size of the hernia defect. The average diameter in the complication group was 8.1±3.0 cm versus 6.4±2.6 cm (p<0.01), and the average defect area reached 57.8 cm<sup>2</sup> (versus 42.7 cm<sup>2</sup>). These parameters are directly related to the technical complexity of the plastic surgery and the need to use non-standard implants.

Functional indicators also played an important role. Patients with complications more often registered ASA classes III-IV (73% versus 50%; p=0.03) and Charlson index > 4 (83.8% versus 36.5%; p<0.01), which emphasizes the importance of the general somatic background in risk assessment. In addition, the group of complications had a significantly higher proportion of patients who had previously undergone surgery without installing a mesh implant (54.1% versus 23.1%; p=0.02), which confirms the limitations of tension techniques in the conditions of tissue failure in patients with PSV.

The results of the analysis showed that the risk of recurrence is influenced by a set of predictors, including anatomical characteristics of the defect, morphological state of the tissues, somatic status and features of the previous tactics.

Inclusion of age in the model made it possible to objectively demonstrate its biological significance: each additional decade increased the risk of recurrence by approximately 80%, and an annual one by 8% (OR=1.08; p=0.012). This confirms that age is not just a statistical variable, but a real clinical and surgical factor reflecting reduced tissue reserve and a high probability of reconstruction failure.

Among the anatomical characteristics, statistically significant independent risk factors were the diameter of the hernia defect >10 cm (OR=2.64) and the area >100 cm<sup>2</sup> (OR=2.41), which reflects the technical complexity of stabilization and increased tension of the edges. Stage III-IV hernia increased the risk by 3 times (OR=3.07), demonstrating not only the mechanical, but also the inflammatory component of the risk. Morphologically significant predictors were the hernia defect (OR=2.20) and especially the thinning of the aponeurosis (OR=3.49), reflecting the functional failure of the APS, which is critical for the fixation and engraftment of the implant. Of the functional factors, the most significant predictor was the Charlson index >4 (OR=4.14; p <0.001), while the ASA class III-IV showed only a tendency to significance (p=0.073), probably due to partial duplication of information between the two scales.

Finally, the absence of an implant in the previous intervention increased the risk of recurrence by almost 2.6 times (p=0.004), emphasizing that tension plastic surgery in patients with severe morphological failure does not provide a reliable result.

As the analysis showed, the following signs had the greatest prognostic significance: patient age, diameter and area of the hernial defect, the presence of BMP and thinning of the aponeurosis, the severity of the adhesion process, a high comorbidity index according to Charlson and the absence of an implant in previously performed interventions. These parameters showed high odds ratio (OR) values and their p-levels of significance ranged from <0.01 to 0.02, except for the ASA parameter, which showed only a trend towards significance.

Additionally, it was taken into account that the development of early postoperative complications, such as seroma, hematoma, suppuration, tissue necrosis or suture failure, can indirectly increase the risk of relapse due to disruption of the biomechanical stability of the implant and delayed healing processes. Thus, the risk of relapse was chosen as the main prognostic criterion, and early complications - as intermediate factors that enhance the manifestation of the main outcome. Based on the integrated assessment of the anatomical, morphological, functional and operational-technical characteristics, a practice-oriented stratification model was built, including three risk levels: low, moderate and high. For each of these categories, well-founded tactical recommendations were proposed, reflecting the required scope of intervention, approach to the choice of access, type of implant and method of its fixation.

The presented point model of risk stratification is based on an integrated assessment of the most significant clinical, anatomical and functional parameters identified during the

multivariate analysis. Each indicator received a quantitative scale of severity (1, 3 or 5 points), reflecting its individual contribution to the development of hernia recurrence. The total score obtained by summing up all the criteria allows us to classify the patient into one of three risk categories (low, moderate or high) and, on this basis, to formulate a personalized laparoscopic surgery strategy. This assessment system ensures ease of use, clinical clarity and prognostic validity.

Patients with a low risk level (total score from 9 to 17) are characterized by the presence of a favorable clinical and anatomical background: small size of the hernial defect (diameter <5 cm, area <25 cm<sup>2</sup>), absence of pelvic ectasia, full structure of the aponeurosis, I-II degree of adhesions.

The moderate risk category (total score 18-30) includes patients with a combination of 2-3 aggravating factors: moderate size of the defect (5-10 cm), local thinning of the aponeurosis, adhesions up to grade III, initial pelvic ectasia.

A high risk of relapse (total score  $\geq 31$ ) is detected in patients with complex anatomical damage to the pelvic ectasia and a severe somatic background. These are individuals over 75 years of age with large defects (diameter > 10 cm, area > 100 cm<sup>2</sup>), pronounced DPM, total thinning of the aponeurosis and grade III-IV adhesions. Most of these patients have a Charlson index  $\geq 5$ , ASA IV, and a history of tension plasty without an implant.

To assess the effectiveness and verify the accuracy of the developed prognostic model and assess its clinical applicability, a ROC analysis was performed to determine the discriminatory characteristics of the scoring scale for stratifying the risk of hernia recurrence in patients with PSV after laparoscopic intervention. The established fact of recurrence was used as a dependent variable, and the total score calculated on the basis of nine integral clinical, anatomical and functional criteria obtained as a result of multivariate analysis was used as a predictor. The area under the ROC curve (AUC) was 0.842 (95% CI: 0.756–0.910;  $p < 0.001$ ), indicating high discriminatory ability of the model. The most informative threshold was  $\geq 18$  points, which achieved an optimal balance between sensitivity (81.2%) and specificity (76.9%). This means that the proposed model allows for highly reliable identification of patients at risk of recurrence, while minimizing the number of false-positive predictions. High sensitivity of the scale is especially valuable in conditions of increased surgical risk in older age groups, where underestimation of unfavorable factors can lead to critical postoperative consequences.

Thus, the obtained results of ROC analysis confirm the clinical efficiency of the proposed risk stratification method and justify its use in tactical planning. Based on these data, an electronic implementation of the model was formed in the form of a software product designed for the prompt stratification of patients with recurrent hernias of the laparoscopic spine. The developed software allows entering individual patient parameters, automatically calculating the total score, classifying the patient as a corresponding risk category and forming on this basis individual recommendations

for choosing the volume and method of laparoscopic intervention. Due to the simplicity of the interface, clinical clarity and adaptability to various patient profiles, the program can be effectively used in the practice of the surgical department as a tool for supporting medical decisions and individualizing surgical tactics.

## 4. Conclusions

1. The developed software allows entering individual patient parameters, automatically calculating the total score, classifying the patient into the appropriate risk category and generating individual recommendations on the selection of the volume and method of laparoscopic intervention.
2. The algorithm is implemented as a complete program. Due to the simplicity of the interface, clinical clarity and adaptability to various patient profiles, the program can be effectively used in the practice of the surgical department as a tool for supporting medical decisions and individualization of surgical tactics.

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