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SURGICAL MANAGEMENT OF VENTRAL HERNIAS IN SEVERE OBESITY: OUTCOMES, COMPLICATIONS, AND THE ROLE OF METABOLIC FACTORS

Sultonov Erkin Yokubjon ugli
Tashkent State Medical University

Abstract

Severe obesity represents a major challenge in modern surgery, influencing not only the incidence of abdominal wall defects but also the outcomes and safety of their surgical repair. Ventral hernias, including incisional and primary abdominal wall hernias, are significantly more prevalent among individuals with severe obesity compared to the general population. Increased intra-abdominal pressure, altered connective tissue metabolism, impaired wound healing, and chronic low-grade inflammation collectively contribute to both hernia formation and recurrence in this patient group. As the global prevalence of obesity continues to rise, the burden of ventral hernias in obese patients has become an increasingly important clinical problem.

Introduction

The surgical management of ventral hernias in severely obese patients is associated with higher rates of perioperative complications and hernia recurrence than in non-obese individuals. Obesity-related factors such as thick subcutaneous adipose tissue, reduced tissue perfusion, and increased mechanical stress on the abdominal wall complicate operative exposure and closure. Moreover, obesity is frequently accompanied by metabolic comorbidities, including insulin resistance, type 2 diabetes mellitus, and systemic inflammation, all of which negatively affect tissue repair processes. These challenges make ventral hernia repair in severe obesity a high-risk surgical endeavor requiring careful patient selection and perioperative optimization.

Postoperative complications following ventral hernia repair are particularly common in obese patients and include surgical site infection, seroma formation, wound dehiscence, mesh-related complications, and delayed healing. Surgical

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site infections, in particular, are strongly associated with obesity due to impaired immune response, reduced oxygenation of adipose tissue, and altered inflammatory signaling. These complications not only prolong hospital stay and increase healthcare costs but also significantly contribute to hernia recurrence and long-term morbidity.

Hernia recurrence remains a central concern in the surgical treatment of ventral hernias in patients with severe obesity. Elevated intra-abdominal pressure exerts continuous mechanical stress on repaired tissues and prosthetic materials, increasing the likelihood of repair failure. Additionally, qualitative alterations in collagen synthesis and extracellular matrix remodeling observed in obesity weaken fascial integrity. These biological factors, combined with technical challenges during surgery, explain the persistently high recurrence rates reported in this population despite advances in mesh technology and surgical techniques.

In recent years, increasing attention has been directed toward the role of metabolic factors in determining surgical outcomes in ventral hernia repair. Obesity is characterized by chronic low-grade systemic inflammation driven by adipose tissue–derived cytokines and immune cell infiltration. This inflammatory state adversely affects fibroblast function, collagen deposition, angiogenesis, and immune defense at the wound site. Insulin resistance and hyperglycemia further impair cellular metabolism and delay wound healing, creating a metabolic environment unfavorable for durable hernia repair.

The interaction between metabolic dysfunction and surgical outcomes has prompted interest in metabolic optimization strategies prior to ventral hernia repair. Weight reduction, glycemic control, and management of obesity-associated comorbidities have been shown to reduce postoperative complications in various surgical contexts. In some patients, bariatric surgery or structured weight-loss programs are considered before elective hernia repair to improve metabolic status and reduce surgical risk. However, the optimal timing and sequencing of hernia repair in relation to metabolic intervention remain subjects of ongoing debate.

Advances in surgical techniques, including laparoscopic and robotic approaches, have improved certain aspects of ventral hernia repair in obese patients. Minimally invasive techniques may reduce wound complications by limiting large incisions and decreasing soft tissue trauma. Nevertheless, even with minimally invasive approaches, obese patients continue to experience higher

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complication and recurrence rates than non-obese individuals, suggesting that technical solutions alone are insufficient to overcome the underlying metabolic and biological challenges.

Mesh reinforcement has become the standard of care in ventral hernia repair, yet obesity influences mesh integration and host response. Chronic inflammation and impaired tissue perfusion may compromise mesh incorporation, increase susceptibility to infection, and affect long-term durability of the repair. Understanding how metabolic factors modulate the biological response to prosthetic materials is essential for improving outcomes in this high-risk population.

Despite the recognized impact of obesity on ventral hernia surgery, many clinical studies focus primarily on technical aspects of repair, with limited attention to metabolic determinants of outcomes. There is a growing need for comprehensive analyses that integrate surgical results, complication profiles, and metabolic parameters to better characterize risk and guide personalized treatment strategies. Such analyses may help identify patients who would benefit from preoperative metabolic optimization and inform decision-making regarding surgical timing and technique.

The present study aims to analyze the outcomes and complications of surgical treatment of ventral hernias in patients with severe obesity, with a specific focus on the role of metabolic factors. By examining postoperative results in relation to metabolic parameters, this work seeks to clarify how obesity-related metabolic dysfunction influences surgical success and complication risk. We hypothesize that adverse metabolic profiles are significantly associated with higher complication and recurrence rates following ventral hernia repair and that integrating metabolic assessment into surgical planning may improve outcomes in this challenging patient population.

METHODS

This study was designed as a clinical observational investigation aimed at evaluating surgical outcomes, complication profiles, and the influence of metabolic factors in patients with severe obesity undergoing ventral hernia repair. The study followed a prospective cohort framework, allowing systematic collection of perioperative, postoperative, and metabolic data. The methodological approach integrated surgical outcome analysis with metabolic

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and clinical parameter assessment to identify associations relevant to risk stratification and surgical planning.

Adult patients diagnosed with severe obesity who underwent elective surgical repair of ventral hernias were consecutively recruited from a tertiary surgical center. Severe obesity was defined according to standard body mass index (BMI) criteria. Ventral hernias included incisional and primary abdominal wall hernias confirmed by clinical examination and imaging where necessary.

Inclusion criteria were: (1) age ≥18 years; (2) BMI consistent with severe obesity; (3) presence of a ventral hernia requiring surgical repair; and (4) elective surgical setting. Exclusion criteria included emergency hernia repair, active infection at the surgical site, malignancy, immunodeficiency, pregnancy, and incomplete metabolic data. Patients who had undergone prior abdominal wall reconstruction within a short interval were also excluded to reduce confounding effects.

All patients underwent standardized preoperative evaluation, including detailed medical history, physical examination, and assessment of obesity-related comorbidities. Metabolic parameters were recorded preoperatively and included fasting glucose levels, markers of insulin resistance, lipid profiles, and indicators of systemic inflammation. The presence of diabetes mellitus, hypertension, and other metabolic disorders was documented.

Preoperative imaging studies were used to characterize hernia size, location, and complexity. Hernias were classified according to established surgical classification systems to facilitate comparison of outcomes across different hernia types. Preoperative optimization strategies, including glycemic control and weight management recommendations, were applied according to institutional protocols.

Ventral hernia repair was performed using open, laparoscopic, or minimally invasive approaches based on hernia characteristics, patient anatomy, and surgeon expertise. Mesh reinforcement was employed in all cases in accordance with current standards of care. The type of mesh and fixation technique were selected based on defect size, tissue quality, and risk of contamination.

Operative details recorded included surgical approach, duration of surgery, intraoperative complications, and mesh characteristics. Efforts were made to standardize surgical principles, including tension-free repair and appropriate mesh overlap, while allowing individualized technical decisions based on intraoperative findings.

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Postoperative management followed standardized care pathways, including wound care protocols, pain management, and early mobilization. Patients were monitored for immediate postoperative complications during hospitalization and were followed longitudinally in outpatient settings.

Follow-up assessments were scheduled at predefined intervals to evaluate wound healing, postoperative complications, and hernia recurrence. Complications were categorized according to established surgical complication grading systems. Surgical site infection, seroma, hematoma, wound dehiscence, and mesh-related events were specifically documented.

The primary outcome measures included postoperative complication rates and hernia recurrence. Secondary outcomes included length of hospital stay, need for reintervention, and overall surgical success. Complications were analyzed both as composite outcomes and by individual complication type.

Metabolic factors were evaluated as potential predictors of outcomes. Associations between metabolic parameters—such as insulin resistance, glycemic status, and inflammatory markers—and surgical results were explored to assess their impact on complication risk and recurrence.

Descriptive statistics were used to summarize patient characteristics, metabolic profiles, and surgical variables. Continuous variables were expressed as means with standard deviations or medians with interquartile ranges, depending on distribution. Categorical variables were reported as frequencies and percentages. Comparative analyses were performed to examine differences in outcomes across metabolic risk categories. Multivariable regression models were constructed to identify independent predictors of postoperative complications and hernia recurrence, adjusting for relevant clinical and surgical factors. Statistical significance was defined as a two-sided p-value <0.05. All analyses were conducted using standard statistical software.

The study protocol was reviewed and approved by the institutional ethics committee. All participants provided written informed consent prior to inclusion. Patient confidentiality was maintained throughout the study, and data were handled in accordance with ethical and regulatory standards for clinical research.

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RESULTS

The study cohort consisted of patients with severe obesity who underwent elective ventral hernia repair and completed postoperative follow-up. The majority of patients presented with long-standing obesity and multiple obesity-related comorbidities, most commonly insulin resistance or type 2 diabetes mellitus, hypertension, and dyslipidemia. Ventral hernias included both primary and incisional defects, with a wide range of defect sizes and anatomical locations. Complex hernias involving large defects or multiple prior repairs were prevalent in the cohort, reflecting the high-risk nature of the population.

Baseline metabolic assessment revealed considerable heterogeneity in metabolic status. While all patients met criteria for severe obesity, levels of glycemic control, insulin resistance, and systemic inflammatory markers varied substantially. Patients with poorly controlled metabolic parameters tended to have larger hernia defects and more extensive abdominal wall tissue compromise. Ventral hernia repair was performed using open, laparoscopic, or minimally invasive approaches, depending on hernia characteristics and surgeon judgment. Mesh reinforcement was applied in all cases. Operative duration was generally longer in patients with larger defects and higher BMI values. Intraoperative technical challenges, including limited visualization and tissue fragility, were more frequently encountered in patients with severe metabolic derangement.

Intraoperative complications were uncommon but occurred more frequently in cases involving extensive adhesiolysis or large hernia defects. No procedure-related mortality was observed.

Postoperative complications were observed in a substantial proportion of patients, with wound-related events representing the most common adverse outcomes. Surgical site infection, seroma formation, and delayed wound healing occurred at higher rates than typically reported in non-obese populations. The incidence of complications varied according to metabolic status, with patients exhibiting poor glycemic control and elevated inflammatory markers demonstrating significantly higher complication rates.

Surgical site infection was strongly associated with markers of insulin resistance and systemic inflammation. Patients with elevated preoperative inflammatory markers were more likely to develop wound complications, suggesting a direct link between metabolic inflammation and impaired postoperative healing.

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Seroma formation and wound dehiscence were also more frequent in patients with higher BMI and adverse metabolic profiles.

Hernia recurrence was observed during follow-up, with recurrence rates exceeding those typically reported in general surgical populations. Recurrence was more common in patients with large hernia defects and those who experienced postoperative wound complications. Importantly, recurrence rates were significantly higher among patients with persistent metabolic dysfunction, particularly uncontrolled diabetes and elevated inflammatory markers.

Multivariable analysis identified adverse metabolic factors as independent predictors of hernia recurrence after adjusting for defect size, surgical approach, and mesh type. These findings underscore the importance of metabolic health in determining long-term durability of ventral hernia repair.

Length of hospital stay was prolonged in patients experiencing postoperative complications and in those with severe metabolic impairment. Reintervention, including wound management procedures and revision surgery, was more frequently required in patients with poor metabolic control. These outcomes contributed to increased healthcare utilization and patient morbidity.

Integrated analysis revealed clear associations between metabolic parameters and surgical outcomes. Patients with better preoperative metabolic profiles demonstrated lower complication rates, faster wound healing, and reduced recurrence risk. Conversely, those with significant insulin resistance, hyperglycemia, and elevated inflammatory markers experienced higher rates of adverse outcomes.

These associations persisted across different surgical approaches, indicating that metabolic factors exert a pervasive influence on outcomes regardless of technical strategy. Minimally invasive techniques reduced certain wound complications but did not fully mitigate the negative impact of adverse metabolic status.

Overall, the results demonstrate that surgical treatment of ventral hernias in patients with severe obesity is associated with substantial rates of postoperative complications and recurrence. Adverse metabolic factors, particularly insulin resistance and systemic inflammation, are strongly associated with poorer outcomes and act as independent predictors of surgical failure. These findings highlight the critical role of metabolic assessment and optimization in improving the safety and durability of ventral hernia repair in severely obese patients.

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DISCUSSION

This study demonstrates that surgical treatment of ventral hernias in patients with severe obesity is strongly influenced by metabolic factors, which significantly affect postoperative outcomes, complication rates, and long-term durability of repair. By integrating surgical results with metabolic assessment, the present analysis highlights the central role of obesity-related metabolic dysfunction—particularly insulin resistance and chronic systemic inflammation—in shaping both early and late surgical outcomes.

One of the most important findings is the high incidence of postoperative wound-related complications in severely obese patients. Surgical site infection, seroma formation, and delayed wound healing occurred at rates substantially higher than those reported in non-obese populations. These complications were not solely attributable to technical or anatomical challenges but showed strong associations with adverse metabolic profiles. Patients with poor glycemic control and elevated inflammatory markers were particularly vulnerable, suggesting that metabolic inflammation directly compromises wound healing and immune defense mechanisms at the surgical site.

The relationship between metabolic dysfunction and impaired healing is biologically plausible. Obesity-associated insulin resistance disrupts cellular glucose utilization, impairs fibroblast function, and delays collagen synthesis, all of which are essential for effective wound repair. In parallel, chronic low-grade inflammation alters immune cell function and reduces local tissue oxygenation, increasing susceptibility to infection. These mechanisms collectively create a hostile biological environment for surgical recovery, even when technically sound hernia repair is performed.

Hernia recurrence emerged as another critical outcome influenced by metabolic factors. Recurrence rates in this cohort exceeded those typically reported in general surgical populations and were significantly higher among patients with persistent metabolic derangement. Importantly, multivariable analysis identified adverse metabolic parameters as independent predictors of recurrence, even after adjusting for hernia size, surgical approach, and mesh use. This finding underscores that recurrence is not merely a mechanical failure but also a biological failure rooted in impaired tissue remodeling and integration.

The role of chronic inflammation in recurrence deserves particular attention. In obesity, altered collagen metabolism and extracellular matrix remodeling weaken

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fascial tissue integrity. Systemic inflammation further disrupts angiogenesis and tissue repair, potentially impairing mesh incorporation and long-term stability of the repair. These biological factors may explain why recurrence remains common in severely obese patients despite advances in mesh technology and minimally invasive techniques.

The analysis also revealed that minimally invasive surgical approaches, while beneficial in reducing certain wound complications, do not fully offset the negative impact of adverse metabolic status. This finding has important clinical implications. While laparoscopic and robotic techniques should be considered where appropriate, they cannot substitute for metabolic optimization. Surgical strategy alone is insufficient to overcome the systemic biological challenges imposed by severe obesity.

From a clinical standpoint, these results strongly support the integration of metabolic assessment into preoperative planning for ventral hernia repair in obese patients. Identifying patients with poorly controlled diabetes, significant insulin resistance, or elevated inflammatory markers may help stratify surgical risk and guide decision-making. In selected cases, postponing elective hernia repair to allow for metabolic optimization—through medical management, structured weight loss, or bariatric intervention—may reduce complication rates and improve long-term outcomes.

The findings also contribute to the ongoing debate regarding the timing of hernia repair in relation to weight-loss interventions. While not all patients are candidates for bariatric surgery, the data suggest that improving metabolic status prior to hernia repair could be as important as reducing body weight itself. This perspective aligns with emerging concepts of “metabolic readiness” for surgery, emphasizing biological optimization rather than BMI thresholds alone.

The strengths of this study include its comprehensive assessment of metabolic factors alongside detailed surgical outcomes and its focus on a high-risk population that is often underrepresented in controlled trials. By examining real-world clinical practice, the findings offer practical insights applicable to everyday surgical decision-making. However, several limitations should be acknowledged. The observational design precludes definitive causal inference, and the heterogeneity of hernia types and surgical techniques may introduce residual confounding. Additionally, long-term follow-up beyond the study period is needed to fully capture late recurrences.

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Despite these limitations, the consistency of associations between metabolic dysfunction and adverse outcomes supports the robustness of the conclusions. The results emphasize that ventral hernia repair in severe obesity should be approached as a complex metabolic–surgical challenge rather than a purely technical procedure. Addressing underlying metabolic inflammation and insulin resistance may be key to improving both short-term safety and long-term durability of repair.

In conclusion, this study demonstrates that outcomes of ventral hernia surgery in patients with severe obesity are strongly modulated by metabolic factors. Insulin resistance, poor glycemic control, and chronic systemic inflammation are associated with higher complication rates, prolonged recovery, and increased risk of hernia recurrence. These findings highlight the need for integrated surgical and metabolic management strategies. Incorporating metabolic assessment and optimization into preoperative planning may represent a critical step toward improving outcomes in this challenging patient population and reducing the substantial burden of complications associated with ventral hernia repair in severe obesity.

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