

ASSOCIATION OF METABOLIC SYNDROME WITH PERIOPERATIVE COMPLICATIONS ACROSS MAJOR SURGICAL PROCEDURES

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Abstract

Background:

Metabolic syndrome (MetS) is a cluster of metabolic abnormalities including central obesity, insulin resistance, hypertension, and dyslipidemia. Patients with MetS undergoing major surgical procedures are at increased risk of perioperative complications due to impaired metabolic and cardiovascular homeostasis. Understanding this association is essential for improving perioperative care and patient outcomes.

Objectives:

To determine the association of metabolic syndrome with perioperative complications across major surgical procedures.

Study Design & Setting:

This observational analytical study was conducted at Sheikh Zayed Hospital Lahore Jan 2025 to June 2025 including patients scheduled for major surgery under general or regional anesthesia.

Methodology:

A total of 120 patients aged 18 years and above were consecutively recruited. MetS was diagnosed using NCEP-ATP III criteria. Demographic data, comorbidities, type of surgery, and perioperative complications—including cardiovascular events, pulmonary complications, surgical site infections, thromboembolic events, and delayed wound healing—were recorded up to 30 days postoperatively. Data were analyzed using SPSS version 25.0, with chi-square and t-tests applied to assess associations.

Results:

MetS was present in 45.8% of patients. Cardiovascular complications were significantly higher in patients with MetS (21.8% vs 4.6%; $p=0.004$). Pulmonary complications (18.2% vs 15.4%), surgical site infections (16.4% vs 13.8%), thromboembolic events (10.9% vs 6.2%), and delayed wound healing (14.5% vs 6.2%) were more frequent in the MetS group, although not statistically significant. Overall, 63.6% of patients with MetS experienced at least one perioperative complication compared to 46.2% without MetS.

Conclusion:

Metabolic syndrome is associated with an increased risk of perioperative complications, particularly cardiovascular events, in patients undergoing major

surgery. Early identification and optimized perioperative management are recommended.

INTRODUCTION

Metabolic syndrome (MetS) is a cluster of interrelated metabolic abnormalities that includes central obesity, insulin resistance, dyslipidemia, and hypertension. It represents a significant public health concern globally due to its increasing prevalence and strong association with cardiovascular disease, type 2 diabetes mellitus, and overall mortality.^{1,2} The prevalence of MetS is rising worldwide, affecting approximately 20–30% of the adult population, with variations depending on ethnicity, age, and lifestyle factors.³ Its pathophysiology involves a complex interplay between genetic predisposition, chronic low-grade inflammation, endothelial dysfunction, and altered adipokine signaling, all of which contribute to the development of systemic complications.⁴

In the context of surgery, patients with MetS pose unique challenges to perioperative care. Surgical procedures, especially major operations, induce significant physiological stress, which can exacerbate underlying metabolic disturbances. The systemic inflammation, oxidative stress, and endothelial dysfunction associated with MetS may predispose patients to a higher risk of perioperative complications, including cardiovascular events, wound healing disorders, infections, and thromboembolic phenomena.^{5,6} Furthermore, components of MetS such as obesity and insulin resistance can complicate anesthetic management, airway handling, and postoperative recovery, thereby increasing morbidity and prolonging hospital stay.⁷ Several studies have highlighted the association between individual components of MetS and adverse surgical outcomes. For instance, obesity is linked to increased risk of surgical site infections and pulmonary complications, while diabetes mellitus is associated with impaired wound healing and heightened susceptibility to infections.^{8,9} Hypertension and dyslipidemia contribute to cardiovascular instability in the perioperative period. However, the cumulative impact of MetS as a syndrome, rather than its isolated components, on perioperative morbidity and mortality is less clearly defined, and evidence remains heterogeneous.¹⁰

The implications of understanding this association are clinically significant. Identification of MetS in preoperative evaluation allows for targeted optimization strategies, including glycemic control, blood pressure management, and lifestyle modification, which may reduce perioperative risk. Moreover, knowledge of the increased susceptibility of these patients to complications can guide perioperative monitoring, anesthetic planning, and postoperative care, ultimately improving patient outcomes and resource utilization.¹⁰

Given the global rise in MetS prevalence and the increasing number of patients undergoing complex surgical procedures, it is imperative to systematically assess the impact of this metabolic disorder on perioperative outcomes. This study aims to evaluate the association of MetS with perioperative complications across major surgical procedures, thereby providing insights that could enhance perioperative risk stratification, optimize clinical management, and inform evidence-based guidelines for patients with metabolic disturbances.

MATERIALS AND METHODS

This observational analytical study was conducted at Sheikh Zayed Hospital Lahore Jan 2025 to June 2025 after obtaining approval from the institutional ethical review board. A total of 120 patients, aged 18 years and above, scheduled to undergo major surgical procedures under general or regional anesthesia were consecutively recruited using non-probability consecutive sampling. Patients with pre-existing chronic inflammatory disorders, immunosuppressive conditions, or incomplete medical records were excluded to minimize confounding variables.

The sample size of 120 patients was calculated using a standard formula for prevalence studies, considering an expected incidence of perioperative complications of 30%, a confidence level of 95%, and a margin of error of 8%. This sample size was deemed sufficient to achieve adequate statistical power for detecting significant associations between

metabolic syndrome and perioperative complications.

Demographic data, medical history, and preoperative clinical parameters were recorded for all participants. Metabolic syndrome was diagnosed according to the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) criteria, which include central obesity, elevated fasting glucose, hypertension, hypertriglyceridemia, and low high-density lipoprotein cholesterol levels. Patients meeting three or more of these criteria were classified as having metabolic syndrome.

All patients underwent standard preoperative assessment, and baseline laboratory investigations, including fasting blood glucose, lipid profile, and renal and liver function tests, were performed. Surgical procedures were categorized according to type, duration, and estimated complexity. Perioperative complications, including cardiovascular events, pulmonary complications, surgical site infections, thromboembolic events, and delayed wound healing, were monitored and recorded during the intraoperative and postoperative periods up to 30 days after surgery.

Data were entered and analyzed using SPSS version 25.0. Continuous variables were presented as mean $\pm$ standard deviation, while categorical variables were expressed as frequencies and percentages. The association between metabolic syndrome and perioperative complications was assessed using chi-square or Fisher's exact test for categorical variables and independent t-tests for continuous variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The study population included 120 patients undergoing major surgical procedures. The age distribution revealed that the majority of patients were between 36–50 years (41.7%), followed by 18–35 years (33.3%) and those older than 50 years (25.0%). Males accounted for 58.3% of the population, while females represented 41.7%. Regarding body mass index, 62.5% of patients were overweight or obese (BMI ≥ 25 kg/m²), and 37.5% had a BMI < 25 kg/m². The types of surgeries performed included general surgery (41.7%),

orthopedic surgery (33.3%), and other major surgeries (25.0%), highlighting a diverse surgical cohort (as given in Table 1).

Among the 120 patients, metabolic syndrome was present in 55 patients, representing 45.8% of the study population, while 65 patients (54.2%) did not meet the criteria for metabolic syndrome. This indicates that nearly half of the patients undergoing major surgeries had metabolic disturbances consistent with MetS (as given in Table 2).

Perioperative complications were observed in a substantial portion of patients. Pulmonary complications were the most common (16.7%), followed by surgical site infections (15.0%), cardiovascular events (12.5%), delayed wound healing (10.0%), and thromboembolic events (8.3%). Notably, 37.5% of patients did not experience any perioperative complications, indicating that while complications were frequent, a significant number of patients had uneventful surgical courses (as given in Table 3).

When the occurrence of complications was compared between patients with and without metabolic syndrome, cardiovascular events were more prevalent in patients with MetS (21.8% vs 4.6%; $p=0.004$), suggesting a significant association. Other complications, including pulmonary complications, surgical site infections, thromboembolic events, and delayed wound healing, were higher in patients with MetS, but these differences did not reach statistical significance ($p>0.05$). Overall, 63.6% of patients with MetS experienced at least one complication compared to 46.2% of those without MetS, indicating a trend toward higher perioperative risk in the MetS group (as given in Table 4).

The distribution of complications by type of surgery among patients with metabolic syndrome showed that general surgery patients had the highest proportion of complications (70.0%), followed by orthopedic surgery (60.0%) and other major surgeries (60.0%). This suggests that the presence of MetS may influence perioperative outcomes across different types of surgical procedures, with general surgery patients being particularly affected (as given in Table 5).

Table 1. Demographic Characteristics of the Study Population (n = 120)

Variable	Frequency	Percentage (%)
Age (years)		
18–35	40	33.3
36–50	50	41.7
>50	30	25.0
Gender		
Male	70	58.3
Female	50	41.7
BMI (kg/m ²)		
<25	45	37.5
≥25	75	62.5
Type of Surgery		
General Surgery	50	41.7
Orthopedic Surgery	40	33.3
Other Major Surgery	30	25.0

Table 2. Prevalence of Metabolic Syndrome in Study Population

Metabolic Syndrome Status	Frequency	Percentage (%)
Present	55	45.8
Absent	65	54.2

Table 3. Distribution of Perioperative Complications (n = 120)

Complication Type	Frequency	Percentage (%)
Cardiovascular events	15	12.5
Pulmonary complications	20	16.7
Surgical site infections	18	15.0
Thromboembolic events	10	8.3
Delayed wound healing	12	10.0
No complications	45	37.5

Table 4. Association of Metabolic Syndrome With Perioperative Complications

Perioperative Complication	Metabolic Syndrome Present (n=55)	Metabolic Syndrome Absent (n=65)	p-value*
Cardiovascular events	12 (21.8%)	3 (4.6%)	0.004
Pulmonary complications	10 (18.2%)	10 (15.4%)	0.67
Surgical site infections	9 (16.4%)	9 (13.8%)	0.70
Thromboembolic events	6 (10.9%)	4 (6.2%)	0.34
Delayed wound healing	8 (14.5%)	4 (6.2%)	0.15
Any complication	35 (63.6%)	30 (46.2%)	0.08

*Chi-square test used for categorical variables

Table 5. Distribution of Complications by Type of Surgery in Patients With Metabolic Syndrome

Surgery Type	Number of Patients with MetS	Number with Complications	Percentage (%)
General Surgery	20	14	70.0
Orthopedic Surgery	20	12	60.0
Other Major Surgery	15	9	60.0

DISCUSSION

Metabolic syndrome (MetS) is a cluster of metabolic abnormalities including obesity, insulin resistance, hypertension, and dyslipidemia. Its prevalence is rising globally, contributing to increased cardiovascular morbidity and mortality. Patients with MetS undergoing major surgery are at higher risk of perioperative complications due to systemic inflammation, endothelial dysfunction, and impaired metabolic homeostasis.^{11,12} Components of MetS, such as obesity and diabetes, may complicate anesthesia and postoperative recovery. Understanding the impact of MetS on perioperative outcomes can guide preoperative risk assessment and targeted management.^{13,14} This study aims to evaluate the association of MetS with perioperative complications across major surgical procedures.

The study includes a well-defined cohort of 120 patients undergoing major surgery, allowing systematic evaluation of perioperative complications. MetS was diagnosed using standardized NCEP-ATP III criteria, ensuring consistent identification of cases. A strength is the comprehensive monitoring of multiple complications, including cardiovascular, pulmonary, infectious, and thromboembolic events. Limitations include the single-center design, which may limit generalizability. The observational nature of the study prevents causal inference. Additionally, potential confounders such as lifestyle factors and medication use could not be fully controlled.

CONCLUSION

Metabolic syndrome is associated with an increased risk of perioperative complications, particularly cardiovascular events, in patients undergoing major surgery. Early identification and optimized perioperative management are recommended.

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