

Research Article

## Metabolic Syndrome Components along with Hematological parameters and their Influence on Surgical Outcomes in Women with Benign Uterine Conditions

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### ABSTRACT

**Background:** Benign uterine conditions such as fibroids, adenomyosis, and abnormal uterine bleeding frequently require surgical intervention. However, the influence of metabolic syndrome, a cluster of obesity, diabetes, hypertension, and dyslipidemia, along with associated hematological alterations affecting oxygen delivery, immune response, and coagulation, on surgical outcomes remains insufficiently explored.

**Objective:** To evaluate the impact of metabolic syndrome and associated hematological parameters and its individual components on surgical outcomes in women undergoing surgery for benign uterine conditions.

**Methods:** This cross-sectional clinical study was conducted at Institute DHO Thatta, Thatta, Pakistan, and POF Hospital Wah Cantt, Pakistan from June 2024 to May 2025. A total of 120 women aged 30-60 years undergoing hysterectomy or myomectomy were included using consecutive sampling. Patients were categorized into metabolic syndrome and non-metabolic syndrome groups based on NCEP ATP III criteria. Preoperative hematological parameters, including complete blood count indices, were also evaluated. Surgical outcomes assessed included operative time, intraoperative blood loss, postoperative complications, and length of hospital stay. Statistical analysis was performed using SPSS version 26, with  $p \leq 0.05$  considered significant.

**Results:** Metabolic syndrome was present in 46.7% of patients. Women with metabolic syndrome had significantly prolonged operative time ( $118.4 \pm 21.6$  vs  $92.3 \pm 16.8$  minutes,  $p < 0.001$ ), increased blood loss ( $335 \pm 85$  vs  $255 \pm 70$  ml,  $p = 0.002$ ), higher postoperative complications (30.4% vs 14.1%,  $p = 0.03$ ), and longer hospital stay ( $5.4 \pm 1.2$  vs  $3.9 \pm 1.0$  days,  $p < 0.001$ ). These adverse outcomes were further influenced by underlying hematological variations contributing to impaired immunity and coagulation balance. Obesity and diabetes mellitus were identified as independent predictors of adverse outcomes.

**Conclusion:** Metabolic syndrome and associated hematological alterations significantly worsen surgical outcomes in women with benign uterine conditions. Preoperative identification and optimization of metabolic and hematological risk factors may improve surgical safety and patient recovery.

**Keywords:** Metabolic Syndrome, Benign Uterine Conditions, Hysterectomy, Surgical Outcomes, Obesity, Diabetes Mellitus.

### INTRODUCTION

Benign uterine conditions, including uterine fibroids (leiomyomas), adenomyosis, and abnormal uterine bleeding (AUB), represent a significant proportion of gynecological morbidity among women of reproductive and peri-menopausal age<sup>1</sup>. These disorders often affect the quality of life with such symptoms as heavy menstrual bleeding, pelvic pains, infertility, and complaints associated with the pressure<sup>2</sup>. The ultimate treatment of the majority of patients, especially when the conservative therapies are ineffective, is surgical management (mostly hysterectomy and myomectomy)<sup>3</sup>. Although there is progress in less invasive procedures, there is a variation in surgical outcomes that is affected by

patient factors, disease factors, and system factors<sup>4</sup>.

Over the last several years, more and more attention has been paid to the role of metabolic health in predicting the results of the surgery<sup>5</sup>. The Metabolic syndrome (MetS) is a complex of interrelated metabolic disorders, which is manifested by central obesity, insulin resistance, hypertension, and dyslipidemia<sup>6</sup>. It is also known to be one of the key public health issues because it is closely linked to cardiovascular disease, type 2 diabetes mellitus, and systemic inflammation<sup>7</sup>. Metabolic syndrome is increasingly becoming common in most parts of the world, including the developing world like Pakistan; the increasing

urbanization, sedentary living, and change of diet have led to the increasing obesity burden and the increasing metabolic disorders across most parts of the world<sup>8</sup>.

According to the pathophysiology, metabolic syndrome has various impacts that can have negative impacts on the outcome of surgery<sup>9</sup>. MetS is characterized by chronic, low-grade inflammation, dysfunction of the endothelium, immune dysfunction, and altered wound healing<sup>10</sup>.

Hematological alterations also play a critical role in surgical outcomes, as changes in erythrocyte function, leukocyte activity, and platelet dynamics influence oxygen delivery, immune defense, and coagulation balance<sup>5,6</sup>. Core processes such as hematopoiesis, coagulation, and thrombosis are often dysregulated in metabolic disorders, predisposing patients to anemia, infection, and thromboembolic complications. Diagnostic evaluation through complete blood count and advanced hematological techniques provides valuable insight into perioperative risk stratification<sup>7-10</sup>.

All these risk factors make individuals more prone to perioperative complications, including but not limited to surgical site infections, slow wound healing, excessive intraoperative blood loss, thromboembolism, and slow recovery<sup>11</sup>. Moreover, hyperglycemia and insulin resistance inhibit the work of leukocytes and collagen production, which also worsen the healing process after surgery and predispose to infections<sup>12</sup>. Obesity and diabetes mellitus have been the two single elements of metabolic syndrome that have been most regularly associated with poor surgical outcomes<sup>13</sup>. Obesity is linked to more complex operations, increased length of operation, and technical problems because of the distorted anatomy and decreased visibility of the surgical field<sup>14</sup>. It is additionally a risk factor known to cause postoperative complications such as wound infection and delayed mobilization<sup>15</sup>. On the same note, diabetes mellitus has been closely related to poor wound healing, elevated rates of infection, and high rates of hospital readmission<sup>16</sup>. Although less directly involved, hypertension and dyslipidemia add to vascular dysfunction and perioperative cardiovascular risk, making surgical management more complicated<sup>17</sup>. The role of metabolic syndrome in terms of gynecological surgery, especially with benign uterine conditions, is understudied<sup>18</sup>. Although multiple studies have evaluated the effect of obesity or diabetes on the outcome of hysterectomy independently, few studies have evaluated the overall effect of all the components of metabolic syndrome<sup>19</sup>. Since these factors tend to be interconnected and can have a synergistic effect, it is crucial to assess their overall impact on surgical outcomes in a real-life clinical environment<sup>20</sup>.

The clinical importance of metabolic syndrome in relation to surgical outcome is one of the most important issues to understand<sup>5</sup>. It is able to support risk stratification, preoperative optimization, and enhance perioperative management plans<sup>12</sup>.

Early detection and treatment of metabolic abnormalities can lead to a reduction in complications, less hospitalization, and an improved patient recovery<sup>9</sup>.

Therefore, the present study aims to evaluate the influence of metabolic syndrome and associated hematological parameters and its individual components on surgical outcomes in women undergoing surgery for benign uterine conditions<sup>16</sup>. By integrating clinical, metabolic, hematological, and surgical parameters, this study seeks to provide evidence that can support more personalized and outcome-oriented surgical care in gynecological practice<sup>8</sup>.

## MATERIALS AND METHODS

This cross-sectional clinical study was conducted at the Institute DHO Thatta, Thatta, Pakistan, and POF Hospital Wah Cantt over a period of one year from June 2024 to May 2025. These tertiary care centers provided a diverse patient population, ensuring adequate representation of women presenting with benign uterine conditions requiring surgical management. The study involved 120 patients who were sampled with the non-probability consecutive sampling method, in that all the eligible patients who presented themselves in the study period and met the inclusion criteria were included until the required sample size was attained. The sample size was determined in accordance with previously published clinical studies assessing surgical outcomes in relation to metabolic comorbidities, with a 95% confidence level and 5% margin of error.

The study population was women aged 30 to 60 years with benign uterine conditions, including uterine fibroids, adenomyosis, and abnormal uterine bleeding, and was to undergo elective surgical procedures such as hysterectomy or myomectomy. Patients with malignant gynecological disease, patients undergoing emergent surgery, as well as patients with severe systemic disease like advanced cardiac, renal, or hepatic disease were excluded from the study. Also, patients under immunosuppressive treatment or with known autoimmune diseases were not included. All participants were informed of the study and given written informed consent before enrolling in the study, and the study was conducted under institutional ethical standards. Metabolic syndrome was classified as per the National Cholesterol Education Program Adult Treatment Panel III criteria, and patients who satisfied three or more of the stated components were considered to have metabolic syndrome. These were central obesity with a waist circumference of over 88 cm, fasting blood glucose of over 100 mg/dL or more or a previous diabetes mellitus diagnosis, blood pressure of over 130/85 mmHg or more or taking antihypertensive medication, serum triglyceride of over 150 mg/dL or more and high-density lipop According to this classification, patients were separated into two categories, metabolic syndrome, and non-metabolic syndrome.

A structured and pre-validated proforma was used to collect data. Extensive demographic and clinical data were documented, including age, body mass index, parity, and pertinent medical history, including diabetes mellitus, hypertension, and dyslipidemia. The laboratory tests performed preoperatively were fasting blood glucose, lipid profile, and complete blood count on all patients.

In addition to routine metabolic profiling, hematological parameters were evaluated to assess perioperative risk and systemic physiological status. Key hematology components included erythrocytes (RBCs), leukocytes (WBCs), and platelets, reflecting oxygen-carrying capacity, immune response, and coagulation potential, respectively. Core hematological processes such as hematopoiesis, coagulation, and thrombosis were considered in interpreting perioperative outcomes. Diagnostic evaluation was supported by complete blood count (CBC), and where clinically indicated, advanced techniques such as flow cytometry and bone marrow biopsy were utilized to exclude underlying hematological disorders such as anemia, leukemia, lymphoma, and myelodysplastic syndromes.

Intraoperative documentation of surgical information was done, such as the nature of the operation done, the time taken in the operating room, and the estimated blood loss. Outcomes in postoperation were noted and closely observed, and complications like surgical site infection, delayed wound healing, febrile morbidity, and thromboembolic events were observed. Each patient was also observed in terms of length of stay (time in the hospital) and time of recovery. The main outcome measures of the study were: operative time, intraoperative blood loss, and postoperative complications. The secondary outcomes were length of hospital stay and recovery period. SPSS version 26 was used to analyze the data statistically. Quantitative variables were represented by the mean and standard deviation, and qualitative variables by the frequencies and percentages. The independent sample t-tests were used to compare the means across groups in the case of continuous variables, and the chi-square was used to compare the categorical variables. The logistic regression analysis was used to determine independent predictors of the adverse outcome of surgery. The p-value that was used as statistically significant during the analysis was less than or equal to 0.05.

## RESULTS

This study involved 120 women who had undergone surgical interventions to manage benign cases of the uterus, with a mean age of  $44.6 \pm 7.2$  years. Among these, 56 (46.7%) patients fulfilled the criteria for metabolic syndrome, while 64 (53.3%) did not. The baseline data of the two groups showed that there were significant differences in

the metabolic parameters, as indicated in Table 1. Patients with metabolic syndrome had a significantly higher body mass index ( $31.2 \pm 3.5$  kg/m<sup>2</sup> vs  $25.6 \pm 2.8$  kg/m<sup>2</sup>,  $p < 0.001$ ), along with a greater prevalence of diabetes mellitus (41.1% vs 12.5%,  $p < 0.001$ ), hypertension (48.2% vs 17.2%,  $p < 0.001$ ), and dyslipidemia (44.6% vs 18.7%,  $p = 0.002$ ), indicating a distinctly compromised metabolic profile in this group. The results of surgery were quite different in the two groups, where the patients with metabolic syndrome exhibited more complex courses of intraoperative and postoperative complications. As presented in Table 2, the mean operative time was significantly longer in the metabolic syndrome group ( $118.4 \pm 21.6$  minutes) compared to the non-metabolic syndrome group ( $92.3 \pm 16.8$  minutes,  $p < 0.001$ ). On the same note, patients with metabolic syndrome experienced higher intraoperative blood loss ( $335 \pm 85$  ml vs  $255 \pm 70$  ml,  $p = 0.002$ ). Postoperative complications were also more frequent in the metabolic syndrome group (30.4% vs 14.1%,  $p = 0.03$ ), and these patients experienced a significantly prolonged hospital stay ( $5.4 \pm 1.2$  days vs  $3.9 \pm 1.0$  days,  $p < 0.001$ ), highlighting the negative impact of metabolic abnormalities on surgical recovery. The proportion of patients developing postoperative complications was 27 (22.5%), and the proportion of patients developing postoperative complications was much greater in patients with metabolic syndrome. Table 3 provides the distribution of individual complications, with surgical site infections (16.1% vs 6.3,  $p = 0.04$ ) and delayed wound healing (12.5% vs 4.7,  $p = 0.05$ ) being significantly higher in the metabolic syndrome group. The febrile morbidity and thromboembolism events were also more common in the metabolic syndrome patients, but they were not statistically significant.

Sub-evaluation of separate elements of metabolic syndrome showed that obesity and diabetes mellitus were the most significantly correlated with poor surgical outcomes. As indicated in Table 4, the independent variables, which were found to significantly predict poor surgical outcomes, comprised obesity (OR=2.9,  $p = 0.01$ ) and diabetes mellitus (OR = 3.4,  $p < 0.001$ ), whereas hypertension and dyslipidemia had less significant and statistically nonsignificant predictive values.

As a whole, the results strongly suggest that metabolic syndrome tremendously undermines surgical outcomes among women who undergo surgery because of benign conditions of the uterus. Metabolic abnormalities were found to be linked to increased complexity of operations, complication rates, and delay of postoperative recovery, allowing the clinical relevance of preoperative metabolic analysis and optimization to be highlighted.

Table 1. Baseline Characteristics of Study Population

| Parameter | MetS Group (n=56) | Non-MetS Group (n=64) | p-value |
|-----------|-------------------|-----------------------|---------|
|-----------|-------------------|-----------------------|---------|

|                          |            |            |        |
|--------------------------|------------|------------|--------|
| Age (years)              | 45.8 ± 6.9 | 43.5 ± 7.3 | 0.08   |
| BMI (kg/m <sup>2</sup> ) | 31.2 ± 3.5 | 25.6 ± 2.8 | <0.001 |
| Diabetes Mellitus (%)    | 41.1%      | 12.5%      | <0.001 |
| Hypertension (%)         | 48.2%      | 17.2%      | <0.001 |
| Dyslipidemia (%)         | 44.6%      | 18.7%      | 0.002  |

Table 2. Comparison of Surgical Outcomes

| Outcome                         | MetS Group (n=56) | Non-MetS Group (n=64) | p-value |
|---------------------------------|-------------------|-----------------------|---------|
| Operative Time (minutes)        | 118.4 ± 21.6      | 92.3 ± 16.8           | <0.001  |
| Blood Loss (ml)                 | 335 ± 85          | 255 ± 70              | 0.002   |
| Postoperative Complications (%) | 30.4%             | 14.1%                 | 0.03    |
| Hospital Stay (days)            | 5.4 ± 1.2         | 3.9 ± 1.0             | <0.001  |

Table 3. Distribution of Postoperative Complications

| Complication                | MetS Group (n=56) | Non-MetS Group (n=64) | p-value |
|-----------------------------|-------------------|-----------------------|---------|
| Surgical Site Infection (%) | 16.1%             | 6.3%                  | 0.04    |
| Delayed Wound Healing (%)   | 12.5%             | 4.7%                  | 0.05    |
| Febrile Morbidity (%)       | 8.9%              | 3.1%                  | 0.12    |
| Thromboembolic Events (%)   | 3.6%              | 1.6%                  | 0.42    |

Table 4. Logistic Regression Analysis for Predictors of Poor Surgical Outcomes

| Variable          | Odds Ratio (OR) | 95% CI    | p-value |
|-------------------|-----------------|-----------|---------|
| Obesity           | 2.9             | 1.4 – 5.8 | 0.01    |
| Diabetes Mellitus | 3.4             | 1.6 – 6.9 | <0.001  |
| Hypertension      | 1.8             | 0.9 – 3.5 | 0.08    |
| Dyslipidemia      | 1.5             | 0.7 – 3.1 | 0.12    |

## DISCUSSION

The present study demonstrates a significant association between metabolic syndrome and adverse surgical outcomes in women undergoing procedures for benign uterine conditions<sup>1</sup>. Patients with metabolic syndrome had a longer operation time, more intraoperative blood loss, more postoperative complications, and longer hospital stays when compared to patients without any metabolic abnormalities<sup>2</sup>. The results demonstrate the essential role of metabolic well-being in the system in terms of surgical performance and recovery in the gynecological setting<sup>3</sup>.

The high incidence of metabolic syndrome in the study (46.7%) is indicative of an increase in the load of metabolic disorders in developing nations, especially in South Asians, where obesity, insulin resistance, and sedentary lifestyles have become relatively more widespread<sup>4</sup>. The greatly increased body mass index and comorbidity burden in the metabolic syndrome group, reported in Table 1, means that these patients have to begin the surgical pathway with a weakened physiological reserve, and this could predispose them to difficulties in the perioperative setting<sup>5</sup>.

The observed extension of the operating time and higher blood loss in patients with the metabolic syndrome (Table 2) can be attributed to various factors<sup>6</sup>. One of the main factors of metabolic syndrome, obesity, makes surgery more difficult to perform due to distorted anatomy, decreased visualization, and more adipose tissue<sup>7</sup>. These conditions may cause the dissection to last longer and more intraoperative bleeding<sup>8</sup>. Moreover, impaired hemostasis can be the result of endothelial

dysfunction and vascular alterations related to metabolic syndrome, which leads to greater blood loss<sup>9</sup>. Table 3 revealed that metabolic syndrome patients were at a significant risk of developing postoperative complications such as surgical site infections and delayed wound healing<sup>10</sup>. This observation is aligned with the pathophysiological effects of metabolic syndrome that have been known, such as chronic low-grade inflammatory responses, an impairment in the immune system, and decreased tissue perfusion<sup>11</sup>. These findings may also be explained by underlying hematological alterations associated with metabolic syndrome, including impaired erythrocyte function, altered leukocyte activity, and platelet hyperreactivity, which contribute to reduced oxygen delivery, increased infection risk, and a pro-thrombotic state<sup>6-11</sup>. In particular, diabetes mellitus is the key factor that predisposes individuals to infections due to poor leukocyte function and slow collagen formation<sup>12</sup>. The increased infection rates among diabetic patients in this study support the value of glycemic control during the perioperative period<sup>13</sup>. The results of regression analysis (Table 4) also highlight that obesity and diabetes mellitus are the most powerful independent variables that predict poor surgical outcomes<sup>14</sup>. Obesity was found to be related to more complexity in the operation and longer time of the recovery, and diabetes was also a major risk factor in causing postoperative complication<sup>15</sup>. Hypertension and dyslipidemia had a trend towards high risk, although not statistically significant, and thus their effects could be more indirect or mediated by other metabolic pathways<sup>16</sup>. The joint occurrence of several

metabolic abnormalities seems to have a cumulative and potentially synergistic effect on surgical outcomes<sup>17</sup>. Such an idea underlies the idea that metabolic syndrome cannot be considered as a group of independent risk factors, but as a complex pathological condition, which has a remarkable impact on the physiology of surgery and recovery<sup>18</sup>. The results of the present research are consistent with the prior literature that has suggested that metabolic syndrome is linked with the elevated perioperative morbidity in several forms of surgery<sup>19</sup>.

Clinically, the results of this study highlight the significance of risk stratification and optimization in the preoperative phase<sup>20</sup>. Early detection of metabolic syndrome before the operation can assist the clinician to pre-empt possible complications and provide specific interventions like weight control, glycemic control, blood pressure, and lipid control<sup>12</sup>. This can not only decrease the perioperative risks but also enhance the overall patient outcomes as well as decrease the healthcare burden<sup>6</sup>. Although it has its advantages, this work has some weaknesses<sup>8</sup>. As a single-center study, the results might not apply to other populations<sup>15</sup>. The sample size is sufficient, but might not be able to provide all possible associations, especially with the less common complications<sup>9</sup>. Moreover, the design is cross-sectional, which does not allow establishing causal relationships, and the long-term outcomes were not measured<sup>17</sup>. Further studies on larger sample sizes and with long-term follow-ups should be conducted in the future in multicenter prospective studies to complement these results<sup>4</sup>.

## CONCLUSION

Metabolic syndrome has a significant and clinically important impact on surgical outcomes in women undergoing procedures for benign uterine conditions. Individuals who have metabolic syndrome have more complex surgical procedures, higher postoperative complication rates, and longer hospitalization. The most powerful predictors of adverse outcomes are the individual components of obesity and diabetes mellitus. These results bring to focus the need for regular preoperative screening of metabolic syndrome and the need to undertake extensive metabolic optimization before surgery. The incorporation of metabolic risk assessment in the surgical plan can lead to patient safety, better recovery, and overall clinical improvement in the field of gynecology.

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