



Epigenetic Associations and Risk Factors for Blood Transfusion in Women undergoing Laparoscopic Myomectomy: A Review

Aseel Abdulrazzaq ^{a++*}

^a Al-Dhannah Hospital, United Arab Emirates.

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Background: Laparoscopic myomectomy is a minimally invasive surgical procedure used to remove uterine fibroids. While generally associated with reduced recovery times and fewer complications compared to open surgery, the risk of blood transfusion remains a significant concern.

Methodology: This narrative review aims to identify risk factors associated with intraoperative and postoperative blood transfusion during laparoscopic myomectomies and to develop a risk stratification tool based on available literature. A comprehensive examination of studies published between July 2015 and February 2024 was conducted using databases such as MEDLINE, ScienceDirect, CINAHL, and PubMed. The search focused on MeSH terms including 'blood transfusion,' 'laparoscopic myomectomy,' 'uterine fibroids,' and 'perioperative care.' After eliminating duplicates, a total of 8 articles were selected for detailed analysis.

⁺⁺ Specialist Obstetrics and Gynecology;

*Corresponding author: E-mail: aseelabdulrazzaqabdulhasanabdu@gmail.com;

Results: Our findings indicate that several demographic and clinical characteristics, including race, preoperative hematocrit levels, and surgical approach, significantly influence the likelihood of requiring a blood transfusion. African American and Hispanic patients were identified as having a higher risk, with preoperative anemia and elevated American Society of Anesthesiologists (ASA) classifications further contributing to increased transfusion rates. The presence of bleeding disorders, larger specimen weights, and prolonged operation times also emerged as key risk factors. The review highlights the need for tailored preoperative assessments, particularly for high-risk demographics, to mitigate transfusion risks. Additionally, preoperative interventions such as correcting anemia and considering uterine artery embolization (PUAE) may help reduce intraoperative blood loss and the subsequent need for transfusion. Although the developed predictive model demonstrates moderate accuracy, further validation in clinical settings is necessary. Implementing such a model in preoperative evaluations could enhance patient outcomes by identifying high-risk patients and enabling the implementation of preventive measures.

Conclusion: Understanding and addressing the identified risk factors are crucial for optimizing surgical outcomes and reducing the need for blood transfusions in women undergoing laparoscopic myomectomies. Further research is recommended to validate these findings and refine risk stratification tools for clinical use.

Keywords: Blood transfusion; myomectomy; laparoscopy.

1. INTRODUCTION

Uterine Myomas are a common condition that many women experience. They can cause issues such as bulk symptoms, abnormal uterine bleeding and infertility which can greatly impact a person's quality of life [1]. Common symptoms of this condition include painful periods, stomach pain, lower back pain, heavy menstrual bleeding, longer or more frequent periods, frequent urination, pelvic pressure or pain, trouble urinating, a growing stomach area and constipation [2]. Myomectomy is a surgical procedure that is performed when other treatments fail to alleviate symptoms of uterine fibroids, such as pain and heavy bleeding during menstrual periods [3]. Laparoscopic Myomectomy is a procedure in which the surgeon will create one or more small incisions in your abdomen [4]. A small tube with a camera will be inserted to examine your uterus. Afterward, small tools will be used to delicately remove the fibroid(s) from your uterus and extract them through the incisions in your abdomen [4]. This procedure can be used to remove fibroids that are up to 10 centimeters in size [4]. There are several treatment options for myomectomy, including surgery, endometrial ablation, uterine fibroid embolization and medication [4]. There are two methods available for this surgery: laparoscopic surgery and open abdominal surgery [4].

A large number of women around the world will develop uterine leiomyomas, with a considerable portion of them requiring treatment [5]. While hysterectomy is frequently performed to address symptomatic myomas, myomectomy offers an

alternative that preserves the uterus and fertility [6].

Considering the diverse nature of myomas and the range of symptoms they can cause, the procedure of myomectomy can be quite complex and carries its own set of risks [7]. One of the most frequent issues that can arise from a myomectomy is significant blood loss, which may require a blood transfusion [7]. This bleeding, which can lead to the need for a blood transfusion, can happen during or after surgery [7]. The rates of transfusion during myomectomy can vary significantly in different studies, ranging from 2.7% to 20% [7]. Numerous studies have been conducted to determine the factors that contribute to perioperative blood loss and the likelihood of needing a transfusion [8]. The risk of transfusion is associated with the type of myomectomy performed [8]. In their study, Stanhiser et al discovered that the risk of transfusion was 4.8 times higher with a laparotomy compared to a laparoscopic approach [9]. In a comprehensive study, the rates of transfusion were observed to be 6.7% for hysteroscopic procedures, 2.7% for laparoscopic procedures, and 16.4% for open/abdominal myomectomies, encompassing both emergent and elective cases [7]. Additional factors that can contribute to increased risk include preoperative anemia and specific characteristics of the myoma [7]. In their study, Murji et al discovered that individuals with preoperative anemia, characterized by a hemoglobin level below 12 g/dL, were nearly twice as likely to require a transfusion [10].

In their study, Vargas et al found that having a myoma diameter of at least 12 cm or a uterine volume of at least 750 cm³ were identified as additional risk factors for transfusion, hemorrhage, and overall complication rates [11].

There are calculators available to help estimate transfusion risk in gynecologic surgery, but they primarily focus on hysterectomy and may not take into account the specific details of myomectomy procedures [12]. Based on the risk factors mentioned earlier, and possibly others that have not been discovered yet, it is possible to calculate a personalized assessment of the risk of transfusion with myomectomy [13]. If the calculated transfusion risk is high, one may consider utilizing certain interventions that are more resource-intensive and variable in cost [14]. These interventions could include the use of gonadotropin-releasing hormone analogs, preoperative blood-product hold, cell-salvage techniques, perioperative uterine artery embolization, preoperative intravenous iron infusions, and temporary occlusion [15]. If the risk is determined to be moderate or low, implementing cost- and resource-containment strategies can be done with confidence [16]. This will result in saving healthcare dollars, preventing surgical delays, and reducing patient morbidity. This narrative review aims to comprehensively assess and analyze the epigenetic associations and risk factors for blood transfusion in women undergoing laparoscopic myomectomy.

2. METHODOLOGY

This narrative review was designed to identify risk factors for intra operative and post operative blood transfusion during laparoscopic myomectomies and to make out from the available literature a risk stratification tool to determine the risk for requiring blood transfusion. In our narrative review of the characteristics associated with blood transfusion among women undergoing laparoscopic myomectomy, we conducted a comprehensive examination of literature across various study designs and methodologies. Our review encompassed publications from July 2015 to February 2024 and utilized databases including MEDLINE, ScienceDirect, CINAHL, and PubMed. We employed MeSH terms such as 'blood transfusion,' 'laparoscopic myomectomy,' 'uterine fibroids,' and 'perioperative care' to ensure a targeted and accurate search. Although MEDLINE and PubMed share overlapping content, both databases were included due to

MEDLINE's longer history (1946) compared to PubMed (1996). This approach resulted in a notable number of duplicate records, which were subsequently removed in the fourth step of our search process. We selected articles in English that focused on relevant clinical trials, observational studies, and health data, excluding review articles and studies with unrelated medical content. After eliminating duplicates and reviewing abstracts, we analyzed a final subset of 8 articles.

3. LITERATURE REVIEW

Demographic characteristics associated with blood transfusion among women undergoing laparoscopic myomectomy:

Observations: A case-control study identified variables independently associated with postoperative/intraoperative blood transfusion at the time of myomectomy [14]. The study involved 6,387 myomectomies performed during the defined study period, with African/Black American patients comprising 45.7% of the population.

Findings: The majority of patients (57.5%) underwent an abdominal/open route of myomectomy. Among these, 623 patients (9.8%) experienced postoperative or intraoperative bleeding that necessitated a blood transfusion. At the bivariable level, several variables were found to be independently associated with the need for a blood transfusion during myomectomy. Further multivariable logistic regression, using only variables that can be reasonably known before surgery, elucidated that blood transfusion, Black race, the need for preoperative a planned abdominal/open route of surgery, and preoperative hematocrit value were independently associated with the need for blood transfusion.

Observation: Researchers conducted a study to identify risk factors for blood transfusion during laparoscopic myomectomies, using a retrospective cohort design [17].

Findings: In the multivariable analysis, several factors were considered as potential risk factors for a blood transfusion. These included operation time, postoperative anemia, intramural myomas, specimen weight, bleeding disorder diagnosis, and race. This study findings also revealed that Hispanic and Black patients had a higher likelihood of blood transfusion compared to non-

Hispanic White patients. The study found that bleeding disorders had a significantly higher adjusted odds ratio (aOR) of 3.38, while ASA class 3 or 4 had a slightly elevated aOR of 1.47. Additionally, preoperative anemia was associated with a higher aOR of 3.20. Specimen weight exceeding 250 g or having a minimum of 5 intramural myomas, along with an operation time of 197 minutes or more, were found to be linked to higher risks of blood transfusion. The associated odds ratios were 1.87 and 4.08, respectively. The results of this study identified the factors that increase the risk of blood transfusion in women undergoing laparoscopic myomectomies. Further studies are recommended to validate these tools and find ways to optimize their use in clinical practice.

Observations: A retrospective cohort study examined the risks of blood transfusion and the morbidity rates within 30 days after myomectomy [7].

Findings: There are several factors that increase the risk of transfusion. These include being of black or other race compared to white race, having a preoperative hematocrit of less than 30%, receiving a preoperative blood transfusion, having a high fibroid burden, undergoing a prolonged surgical time, and opting for an open/abdominal approach instead of a laparoscopic one. Even after accounting for other factors, it was found that women who needed blood transfusions were about three times more likely to experience a major postoperative complication (adjusted odds ratio 2.69).

Observation: In this issue of Fertility and Sterility, the study by Kim et al. aimed to understand the risk of blood transfusion following myomectomy for symptomatic uterine fibroids [18].

Findings: They analyzed a database containing information from over 600 centers spanning from 2010 to 2016. The authors have included 3,407 myomectomy procedures in their study to define the risks associated with hysteroscopic, laparoscopic, and open/abdominal procedures. In this study, it was discovered that the risk of blood transfusion after myomectomies varied depending on the type of procedure. Laparoscopic myomectomy was associated with the lowest risk, while open/abdominal myomectomy had the highest risk. Furthermore, the authors also assessed the rate of 30-day morbidity after myomectomy as a secondary

outcome. Even when considering other factors, there was a noticeable rise in the likelihood of major postoperative complications for patients who underwent a blood transfusion.

Observation: A significant study aimed at developing a blood transfusion prediction model for laparoscopic myomectomy analyzed data from the National Surgical Quality Improvement Program (NSQIP), encompassing 11,496 cases from 2012 to 2020 [19].

Findings: The study identified that 2.9% of women undergoing laparoscopic myomectomy required blood transfusions, underscoring the need for better predictive tools and risk management strategies in clinical practice. Several risk factors were found to significantly contribute to the likelihood of requiring a blood transfusion during the procedure. Non-Hispanic Black race emerged as a prominent risk factor, indicating a higher propensity for transfusion needs among this demographic. This finding suggests the importance of tailored preoperative assessments and interventions to mitigate transfusion risks in non-Hispanic Black women. Additionally, the presence of bleeding disorders was another critical predictor, highlighting the necessity for meticulous preoperative planning and potential prophylactic measures to manage bleeding risks effectively. The study also revealed that a higher American Society of Anesthesiologists (ASA) classification was linked to increased transfusion rates, suggesting that patients with significant comorbidities require more intensive monitoring and preparation. Preoperative anemia was identified as a strong predictor of transfusion need, emphasizing the importance of correcting anemia before the procedure to reduce the likelihood of requiring a transfusion and improve patient outcomes. Other significant factors included larger specimen weights and longer operation times, which pointed to the complexity and invasiveness of the procedure as contributing factors to blood loss.

The predictive model developed from these findings demonstrated moderate accuracy, with researchers emphasizing the need for further validation and refinement in clinical settings to ensure its effectiveness and reliability. Incorporating this model into preoperative evaluations could aid in identifying high-risk patients and implementing appropriate preventive measures to reduce transfusion rates, thereby improving surgical outcomes and patient care.

Observation: Another study explored the potential of preoperative uterine artery embolization (PUAE) to reduce intraoperative blood loss in myomectomy procedures [9].

Findings: PUAE is designed to decrease blood flow to the uterus by embolizing the uterine arteries, potentially minimizing intraoperative bleeding and reducing the need for blood transfusions. The study conducted a retrospective analysis of 16 patients who underwent PUAE before myomectomy. The results showed trends towards reduced bleeding and shorter operative times in patients who had undergone PUAE compared to those who had not. The findings also revealed modifiable factors such as preoperative anemia and intraoperative bleeding that were found to be directly targeted by PUAE.

These findings suggest that PUAE could be a valuable preoperative intervention to minimize intraoperative bleeding, thus reducing the need for blood transfusions. However, the results were not statistically significant, primarily due to the small sample size, indicating that larger studies are needed to confirm these preliminary findings.

The observation of shorter surgical durations for patients who had PUAE could be attributed to easier surgical dissection and reduced intraoperative complications, contributing to quicker and safer surgeries. Despite these promising trends, the main limitation of this study was its small sample size, which affected the statistical power of the findings. To confirm the benefits of PUAE, larger and more comprehensive studies are necessary. Furthermore, future research should explore the long-term outcomes of PUAE, including its impact on fertility and postoperative recovery.

Preoperative characteristics associated with blood transfusion among women undergoing laparoscopic myomectomy:

Observation: In a study, 26,229 women underwent a myomectomy. Among them, 2,345 (9%) required a blood transfusion [20].

Findings: Women who needed a transfusion had lower median preoperative hematocrit levels (34.7) compared to those who did not (38.2). Patients were grouped based on their surgical approach (laparotomic vs. laparoscopic) and the number and weight of myomas (1–4 myomas/weight ≤ 250 g or ≥ 5 myomas/weight > 250 g), using Current Procedural Terminology codes (58140, 58146, 58545, 58546). The data

showed a clear correlation between the need for a blood transfusion and lower preoperative hematocrit levels across all categories, with the risk of transfusion increasing as hematocrit levels decreased. The odds ratios comparing hematocrit levels of 29% versus 39% were significantly different for patients who had laparotomic versus laparoscopic myomectomy. These odds ratios ranged from 4.85 to 6.16, with the corresponding confidence intervals indicating a strong association.

Observation: A study assessed the impact of preoperative anemia on blood transfusion rates in laparoscopic myomectomy [21].

Findings: Including data from 2,345 patients, researchers found that lower preoperative hematocrit significantly increased transfusion risk. Other important factors were race, BMI, and ASA classification. Addressing preoperative anemia was recommended to minimize transfusion needs and enhance surgical outcomes.

4. RESULTS

In this review, several studies consistently identified key risk factors for intraoperative and postoperative blood transfusions in women undergoing laparoscopic myomectomies. Factors such as race, particularly among African American and Hispanic women, lower preoperative hematocrit levels, bleeding disorders, and prolonged surgical times were strongly associated with increased transfusion risk. Additionally, an open/abdominal surgical approach, as opposed to laparoscopic methods, was linked to a higher likelihood of transfusion. Other significant predictors included the presence of intramural myomas, larger specimen weights, and higher ASA classifications, suggesting that complex cases and patients with significant comorbidities require more intensive preoperative management to reduce the risk of transfusion. The predictive models developed in these studies demonstrate moderate accuracy, emphasizing the need for further validation and refinement in clinical settings to enhance patient outcomes.

5. DISCUSSION AND ANALYSIS

In this study some of the following factors were noted and assessed in order to determine the probability of blood transfusion during myomectomy operations. Some of the findings

include race which showed that African American and Hispanic women had a higher probability of a transfusion. This is in line with other published literature like the study by Carry et al where they also found out that there were differences in transfusion rates based on race during gynecologic surgeries [22]. These differences might be explained by such factors as initial hemoglobin levels, the severity of surgery, and patients' socioeconomic status, which should be studied further to design specific interventions.

The other preoperative parameter that was considered was the hematocrit level and patients with lower hematocrit levels required transfusion more often. This is in line with the study by Cao et al who also stressed on the need to manage preoperative anemia to reduce risks of transfusion [23]. The fact that this association has been observed in other studies shows that there is a need for strict preoperative evaluation and preparation of patients for myomectomy especially in regard to hematocrit levels.

In addition, the choice of the surgical technique, laparoscopic or open/abdominal, was a predictor of the risk of transfusion. According to the review, the estimated average of transfusion is lower in laparoscopic myomectomies than in open surgeries, as also affirmed by Chen et al [24]. This implies that any time possible, less invasive approaches should be employed to decrease on blood loss and enhance the postoperative results.

6. CONCLUSION

This study analyzed the characteristics associated with blood transfusion among women undergoing laparoscopic myomectomy. This review highlights that several modifiable and non-modifiable risk factors contribute to the likelihood of requiring a blood transfusion during laparoscopic myomectomy. Non-modifiable factors include race (with non-Hispanic Black patients showing a higher risk) and inherent bleeding disorders. Modifiable factors encompass preoperative anemia, specimen weight, and the choice of surgical approach. Effective preoperative management strategies, such as correcting anemia and considering interventions like preoperative uterine artery embolization (PUAE), may help mitigate these risks. Tailored strategies based on individual patient profiles could enhance surgical outcomes and reduce transfusion-related complications. Further study is required and essential to refine predictive models, validate the efficacy of

preoperative interventions, and provide evidence based guidelines for optimizing patient care.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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