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Hematological and Inflammatory Parameters to Predict the Develop Surgical Site Infection After Cesarean Section

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Abstract

Objective: This study seeks to illustrate the efficacy of inflammatory hematological markers in patients who develop site infections following a cesarean section, while also establishing reference values for these parameters.

Methods: This retrospective, single-center study was conducted at Ordu University Training and Research Hospital from January 2016 to January 2023. A comparison was made between 42 cases where surgical site infection developed after cesarean section and 42 cases. The data for this study were obtained from hospital medical records, which encompass of demographic, general medical, obstetric, and neonatal information. Preoperative complete blood count (CBC) was included in the analysis.

Results: Statistically significant differences were observed among preoperative hematological and inflammation markers, including "PLT, WBC, NOT, PCT, MLR, DNLR, NLO, PLO, MPVPR, LP, RDWPR, NLRNPR, SII. ROC analysis revealed that optimal cutoff values were statistically significant for most laboratory parameters and blood count-derived ratios in patients with post-Cesarean wound infection. The largest AUC for SII was 0.861 with the cut-off value of 892.03 (sensivity %76 and specifity %76).

Conclusion: This article has revealed differences between hematological and inflammatory markers in patients developing complications at the incision site after cesarean section. To assess the risk of surgical site infection development and reduce morbidity and hospitalization durations, further research in this area is needed.

Keyword: Complete Blood Count, Hematological Parameters, Pregnancy

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INTRODUCTION

Cesarean section (CS) is a widely performed surgical procedure that has been in practice for over a millennium, making them one of the oldest surgical interventions in history (1).

While generally considered safe, Cesarean section (CS) can give rise to several complications, such as excessive blood loss, injury to nearby organs, infections, and the development of adhesions (2). Infectious complications that occur after a Cesarean section (CS) can be categorized into two groups: general infections, which encompass pneumonia, urinary tract infections, mastitis, pyelonephritis and specific gynecological infections such as ovarian vein thrombosis, endometritis, and surgical site infection (SSI). The occurrence rates of endometritis and surgical site infections (SSI) fall within a range of 0.3% to 7.3% for endometritis and 1% to 23% for SSI (3). Post-operative infections following cesarean section, particularly surgical site infections (SSI), significantly contribute to patient morbidity and mortality. They lead to extended hospital stays, hinder the quality of patient recovery, and place a substantial financial strain on healthcare systems.

Various factors increase the risk of specific gynecological infections after cesarean sections. Several factors increase the risk of certain gynecological infections after a caesarean section. These include younger maternal age, obesity, diabetes, immunosuppressive disorders, corticosteroid therapy, reduced frequency of antenatal care, chorioamnionitis, history of repeated caesarean section, emergency caesarean section and 60-minute surgery, wound closure with staples, and excessive blood loss (4). Diverse approaches have been suggested to mitigate the incidence and severity of post-cesarean section infections. These include preoperative antiseptic showers, preoperative preparation of the incision site with antiseptics, administration of prophylactic antibiotics, avoidance of manual placenta removal, and prompt removal of urinary catheters (5).

In recent years, there is accumulating suggests regarding the potential utilization of hematological indicators such as Mean Platelet Volume (MPV), Plateletcrit (PCT), Red Blood Cell Distribution Width (RDW), Platelet-to-Lymphocyte Ratio (PLR), Platelet-Lymphocyte Ratio (PLR), Neutrophil-Lymphocyte Ratio (NLR), Derived Neutrophil-Lymphocyte Ratio (d-NLR), Monocyte-Lymphocyte Ratio (MLR), Neutrophil-Platelet Ratio (NPR), Mean Platelet Volume-Platelet Ratio (MPVPR), Lymphocyte times Platelet (LxP), Red Cell Distribution Width-to-Platelet Ratio (RDWPR), NLRNPR (NLR/NPR), and SII (Systemic Immune Inflammation index as indicators of systemic inflammation, especially in asymptomatic cases where other systemic inflammation markers are not elevated, NLR

and PLR can be readily computed by dividing the absolute count of neutrophils or platelets, respectively, by the absolute count of lymphocytes (6).

These indicators contribute to inflammation and the processes associated with inflammation. They have demonstrated their predictive potential in various medical fields, including gastroenterology, oncology, cardiology , and orthopedics (7). More recently, NLR and PLR have been the subject of research in the field of obstetrics and gynecology. These markers have been associated with a range of conditions, including polycystic ovary syndrome, endometriosis, ovarian hyperstimulation syndrome, and adverse pregnancy outcomes such as preeclampsia and gestational diabetes (GDM) (8, 9).

Considering the increasing rate of cesarean sections, the prevalence of specific gynecological infections after high-risk cesarean procedures, and the potential benefits of utilizing existing blood tests with predictive capabilities, we aimed to investigate whether routine hematological indices obtained before and after cesarean sections can be associated with and aid in the early prediction of the development of specific gynecological infections.

METHODS

This retrospective, single-center study was conducted at Ordu University Training and Research Hospital from January 2016 to January 2023. Due to being the largest women's health and maternity clinic in the Ordu region, this hospital conducts a significant number of cesarean operations. This study was conducted with the approval of the Ordu University Ethics Committee. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

A comparison was made between 42 cases where surgical site infection developed after cesarean section and 42 cases where it did not, within the dates of 01/01/2016 to 01/06/2023 at the Department of Obstetrics and Gynecology of Ordu University Faculty of Medicine Training and Research Hospital. After the first three days, infections that developed were included in the study. The study will not include cases with missing data, such as those with placental abruption, vasa previa, placenta previa, cord prolapse, uterine rupture, and emergency cesareans due to fetal distress. Additionally, cases with a history of chorioamnionitis and early membrane rupture, as well as cesareans performed with incisions other than Pfannenstiel, will be excluded. Patients with a BMI greater than 35, cases with acute and/or chronic known maternal infections, and individuals who have recently used corticosteroids for any reason will not be part of the study. Furthermore, cases with various hematological conditions like idiopathic thrombocytopenia purpura,

thrombotic thrombocytopenic purpura, and hematological malignancies will be excluded. Patients with diseases that can alter complete blood count, such as systemic lupus erythematosus, nephropathy, renal, or hepatic dysfunction, will also not be included. Finally, individuals who did not receive preoperative prophylactic antibiotic therapy will be excluded from the study.

The data for this study were obtained from hospital medical records, which encompass a wide range of demographic, general medical, obstetric, and neonatal information. Preoperative complete blood count (CBC) was included in the analysis. The study assessed various Complete Blood Count (CBC) variables, including hemoglobin, hematocrit, mean corpuscle volume, red blood cell distribution width, white blood cells, neutrophils, lymphocytes, platelets, and mean platelet volume. Furthermore, from these variables, calculations were performed to derive metrics such as Mean Platelet Volume (MPV), Plateletcrit (PCT), Red Cell Distribution Width (RDW), Platelet-to-Lymphocyte Ratio (PLR), Systemic Inflammation Markers like Neutrophil-to-Lymphocyte Ratio (NLR), derived Neutrophil-to-Lymphocyte Ratio (d-NLR), Monocyte-to-Lymphocyte Ratio (MLR), Neutrophil-Platelet Ratio (NPR), Mean Platelet Volume-Platelet Ratio (MPVPR), Lymphocyte multiplied by Platelet (LxP), Red Cell Distribution Width-to-Platelet Ratio (RDWPR), NLRNPR (NLR/NPR), and SII (Systemic Immune Inflammation Index).

Women were categorized as having a postoperative surgical site infection if they experienced an elevation in body temperature or displayed indications of a surgical site infection throughout their postoperative hospital stay. Additionally, this classification extended to those who were rehospitalized within six weeks after childbirth due to symptoms of fever or surgical site infection.

The SPSS 21 program was planned to be used for the comparison of numerical data as follows: Student t-test for two-group comparisons, One Way Anova for comparisons involving more than two groups, Chi-square and Fisher Exact tests for comparing categorical data. The analyses will be carried out at a 95% confidence level (p=0.05). Descriptive statistical methods and correlation analyses will be utilized in the research. Data acquired from the study will be depicted in a presentation format as the average value along with the associated standard deviation. The normal distribution of numerical variables will be assessed using the Kolmogorov-Smirnov and Shapiro-Wilks tests. Independent samples t-test will be applied for numerical variables showing a normal distribution, while the Mann-Whitney U test will be used for those not showing a normal distribution. The analysis of the Receiver Operating Characteristic (ROC)

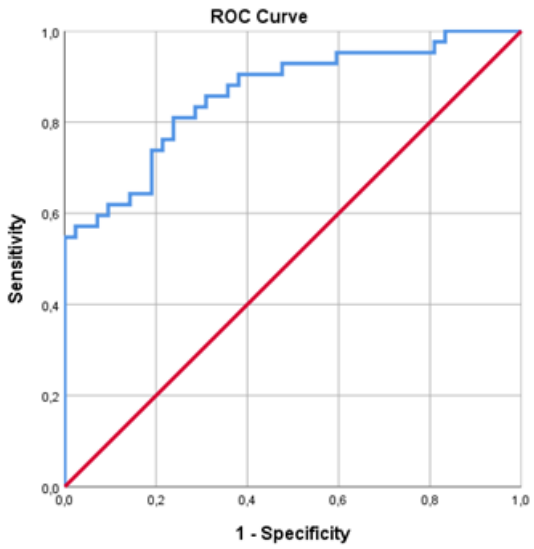
curve will be conducted, and the Area Under the Curve (AUC) will be interpreted as follows: AUC between 0.9 and 1 is considered excellent, AUC between 0.8 and 0.9 is good, AUC between 0.7 and 0.8 is fair, AUC between 0.6 and 0.7 is poor, and AUC between 0.5 and 0.6 is considered unsuccessful.

RESULTS

In the study, 42 cases of post-Cesarean section wound infections were compared with 42 cases in the control group. The demographic data, including age and BMI (Body Mass Index), did not show any significant differences between the groups. Statistically significant differences were observed among preoperative hematological and inflammation markers, including "PLT, WBC, NOT, PCT, MLR, DNLR, NLO, PLO, MPVPR, LP, RDWPR, NLRNPR, SII.The hospitalization durations of patients, the 1st and 5th minute APGAR scores of the infants, and umbilical cord pH values did not show any statistically significant difference (Table 1).

Table 1. Hematologic indices, hematologic ratios

Preop Blood Samples	Surgical Site İnfection	Control	P Value
PLT	271.43±65.31	210.71±49.87	<0.001
WBC	11.43±2.85	9.22±2.20	<0.001
NEU	8.63±2.50	6.46±1.57	<0.001
PCT	0.25±0.05	0.22±0.04	0.01
dNLR	3.27±1.16	2.43±0.52	<0.001
NLR	4.54±1.66	3.35±0.80	<0.001
PLR	141.06±39.58	112.63±34.54	0.001
MPVPR	0.039±0.011	0.053±0.015	<0.001
LYM*PLT	575.14±297.61	429.85±192.66	0.01
RDWPR	0.167±0.045	0.212±0.056	<0.001
NLRNPR	101.92±29.02	81.89±25.03	0.001
SII	1191.90±339.54	700.79±207.48	<0.001



Graphic 1. SII Roc Analysis

ROC analysis revealed that optimal cutoff values were statistically significant for most laboratory parameters and blood count-derived ratios in patients with post-Cesarean wound infection (Graphic 1). The largest AUC for SII was 0.861 with the cut-off value of 892.03 (sensivity %76 and specifity %76). "PLT, WBC, Neutrophil, D-NLR, and NLR have been observed at a moderate level (0.7-AUC-0.8)

DISCUSSION

In this study, the effect of hemogram parameters and inflammatory markers on predicting postoperative infections in the surgical area following cesarean section was investigated. There is currently an insufficient number of studies related to predicting the development of incision site infections after cesarean section. Predictability with inflammation markers and adapting parameters commonly examined in other diseases for incision site infections following cesarean

section is limited. Full blood count is an excellent choice due to its cost-effectiveness and easy accessibility. In preoperative complete blood counts, the number of platelets, white blood cells, and neutrophils was significantly higher in patients who developed surgical site infections after cesarean section. Platelet counts can increase in response to inflammation. This is because platelets play a crucial role in the body's immune response and inflammation processes. When inflammation occurs, the immune system triggers an increase in platelet production to aid in the repair of damaged tissues (10). Feng et al. study has shown that platelets are significantly elevated in individuals with Crohn's disease, an inflammatory condition. This finding is associated with the disease activity of Crohn's (11). White Blood Cell (WBC) and neutrophils can increase during inflammation because the body's immune system responds. When an inflammatory process occurs, the immune system mobilizes white blood cells to combat infections, injuries, or other forms of tissue damage. This elevated WBC and neutrophil count is a result of the immune system's effort to defend the body (12). According to the results obtained in your study, you observed that platecrit values were significantly higher in the group that developed surgical site infections. Additionally, in a study conducted by Çelik et al. involving patients with ST-Elevated Myocardial Infarction (STEMI), it was shown that patients with higher platecrit values had worse long-term angiography outcomes (13). In the study conducted by Işık et al., it was found that plateletcrit (PCT) values were significantly higher in patients who experienced preterm birth (14).

In our study, we found that the derived neutrophil-to-lymphocyte ratio was significantly higher in patients who developed surgical site infections. Belaj et al. also observed a similar trend, with elevated values of this ratio in patients with leg ischemia (15). In our study, we found a significantly elevated neutrophil-to-lymphocyte ratio (NLR) in patients who developed surgical site infections. Similarly, in the study conducted by Biyik et al. (16), it was observed that patients who experienced spontaneous abortion in the first trimester had higher NLR values. Yuce research also indicated that pregnant women who delivered prematurely had higher NLR values compared to those who gave birth at term (17). The platelet-lymphocyte ratio is considered an important indicator for assessing inflammation. In our research, we observed that the platelet-lymphocyte ratio was significantly higher in patients who developed surgical site infections. Similarly, a study conducted by Keles et al indicated that the platelet-lymphocyte ratio was significant in determining the spectrum and histological type of placenta accreta (18). In our study, we found a significantly lower mean platelet

volume/platelet count ratio in the group that developed infections. Zhang et al had previously shown that in colorectal cancer, tumor markers were elevated, while they were significantly lower in the group of patients who developed lymph node invasion (19). In our study, we found that the value obtained by multiplying lymphocytes with platelets was significantly higher in the group that developed infections. However, in a study conducted by Zhu et al., they observed that in the group of children under 6 years old who developed influenza, the value obtained by multiplying lymphocytes with platelets were significantly lower (20). In our study, we found that the Red Cell Distribution Width-to-Platelet Ratio (RDW-PLT ratio) were significantly lower in the group that developed infections. Similarly, Wang et al have also shown that the RDW-PLT ratio is significantly lower in newborns with good neonatal intensive care unit outcomes (21). In our study, we found that the Neutrophil-to-Lymphocyte Ratio (NLR) /Platelet-to-Lymphocyte Ratio (NPR) values were significantly higher in the group that developed infections. Similarly, Keskin et al., in their study on pregnant women with COVID-19, found that the NLR /NPR values were significantly higher in those who experienced severe infections compared to those with mild infections (22). In our study, we found a significant increase in the Systemic Immune Inflammation Index in the group with infections. Akdulum and colleagues, in their research, examined routine blood samples from patients throughout pregnancy who developed preeclampsia. They found that the Systemic Immune Inflammation Index was significantly higher in the group that did not develop preeclampsia (23).

In this study, the advantage is that all the women examined were patients who underwent surgery and were followed by the same team in the same center. This study is one of the first in this regard. However, unfortunately, the retrospective design of the study and the small sample size are limitations of this study.

CONCLUSION

The objective of this investigation is to examine hematological parameters linked to the occurrence of wound infections following cesarean sections and to distinctly outline all the inflammation indices easily obtainable through a basic blood count. This study primarily discloses that individuals experiencing post-cesarean section wound infections show associations with elevated white blood cell count, increased neutrophil count, as well as heightened platelet, platelet crit, neutrophil-to-lymphocyte ratio (NLR), derived neutrophil-to-lymphocyte ratio (dNLR), platelet-to-lymphocyte ratio (PLR), average platelet volume-platelet ratio (MPVPR), lymphocyte time-platelet count (L*P), red blood cell to platelet distribution width ratio (RDWPR), systemic immune index

(SII), and neutrophil-lymphocyte-platelet ratio (NLNPR).

Although these markers have been investigated in the broader populace, there is a scarcity of research within the existing literature focused on pregnant individuals. Further studies are essential to identify patients at risk of developing post-Cesarean section wound infections and to mitigate both morbidity and the duration of hospitalization.

Ethics Committee Approval: Ethics Committee Approval: Ethics approval for this study was obtained from the Ordu University Senate Ethics Committee (ethics committee date and number: 21.07.2023 and 192)

Peer-review: Externally peer-reviewed

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