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Evaluation of inflammatory response with complete blood count parameters in abdominal, vaginal, and laparoscopic hysterectomy techniques: A retrospective Cohort study

Abdominal, vajinal ve laparoskopik histerektomi tekniklerinde tam kan sayımı parametreleriyle enflamatuvar yanıtın değerlendirilmesi: Retrospektif Kohort çalışması

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ABSTRACT

Aim: The aim of our study was to evaluate the inflammatory response in abdominal hysterectomy (AH), vaginal hysterectomy (VH), and laparoscopic hysterectomy (LH) techniques using complete blood count (CBC) parameters and to demonstrate the role of the delta neutrophil index (DNI) in hysterectomy types.

Materials and Methods: The study included 251 patients. Patients were divided into three groups: AH, VH, and LH. Patient demographic characteristics, operational characteristics, and CBC results (white blood cell (WBC), neutrophil/lymphocyte ratio (NLR), platelet/lymphocyte ratio (PLR), and DNI) were compared separately for the three groups before surgery, at 6 hours postoperatively, and at 24 hours postoperatively.

Results: The age and menopause rate of patients in the VH (n=84) group were higher than the LH (n=82) and AH (n=84) groups (P<0.05). The operative time was longest in the LH group and shortest in the AH group (P<0.05). The highest WBC, NLR, and PLR levels at postoperative 6th hour were in the AH group, and the lowest levels were in the VH group (P<0.01). There were no significant differences in serum DNI levels between the LH, AH, and VH groups preoperatively and at the 6th and 24th hours postoperatively.

Conclusion: We found the highest postoperative inflammatory response in the AH group and the lowest in the VH group, and contrary to many studies, we found that LH patients had an average inflammatory response. Although DNI increased in the postoperative inflammatory process, there was no difference between the AH, LH, and VH groups.

Keywords: Abdominal hysterectomy, vaginal hysterectomy, laparoscopic hysterectomy, WBC, NLR, PLR, DNI

ÖZ

Amaç: Çalışmamızın amacı, abdominal histerektomi (AH), vajinal histerektomi (VH) ve laparoskopik histerektomi (LH) tekniklerinde inflamatuar yanıtı tam kan sayımı (CBC) parametrelerini kullanarak değerlendirmek ve delta nötrofil indeksinin (DNİ) histerektomi tiplerindeki rolünü ortaya koymaktır.

Gereç ve Yöntemler: Çalışmaya 251 hasta dahil edildi. Hastalar AH, VH ve LH olmak üzere üç gruba ayrıldı. Hastaların demografik özellikleri, operasyonel özellikleri ve CBC sonuçları (beyaz kan hücresi (WBC), nötrofil/lenfosit oranı (NLR), trombosit/lenfosit oranı (PLR) ve DNI), ameliyat öncesi, ameliyat sonrası 6. saatte ve ameliyat sonrası 24. saatte üç grup için ayrı ayrı karşılaştırıldı.

Bulgular: VH (n=84) grubundaki hastaların yaş ve menopoz oranı, LH (n=82) ve AH (n=84) gruplarına göre daha yüksekti (P<0,05). Ameliyat süresi LH grubunda en uzun, AH grubunda ise en kısaydı (P<0,05). Ameliyat sonrası 6. saatte en yüksek WBC, NLR ve PLR seviyeleri AH grubunda, en düşük seviyeler ise VH grubundaydı (P<0,01). LH, AH ve VH grupları arasında ameliyat öncesi ve ameliyat sonrası 6. ve 24. saatlerde serum DNI seviyelerinde anlamlı bir fark yoktu.

Sonuç: Ameliyat sonrası en yüksek inflamatuar yanıtı AH grubunda, en düşük ise VH grubunda bulduk ve birçok çalışmanın aksine, LH hastalarının ortalama bir inflamatuar yanıta sahip olduğunu bulduk. DNI ameliyat sonrası inflamatuar süreçte artmasına rağmen, AH, LH ve VH grupları arasında bir fark yoktu.

Anahtar Kelimeler: Abdominal histerektomi, vajinal histerektomi, laparoskopik histerektomi, WBC, NLR, PLR, DNI

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INTRODUCTION

Surgical procedures have a significant impact on inflammatory processes in the body. Surgical trauma caused by surgery can trigger an inflammatory response, potentially leading to various postoperative complications. It is essential to understand and regulate this inflammatory process to enhance patient outcomes and minimize the risk of postoperative morbidity (1).

Among women, hysterectomy is the second most common surgical procedure after cesarean section. Despite its frequency, hysterectomy remains a major operation with possible long-term effects on women's health and quality of life (2). For benign uterine conditions, there are three approaches to hysterectomy: abdominal, vaginal, and laparoscopic. Regardless of the method used, hysterectomy is considered a substantial surgical intervention. Research has demonstrated that such significant surgical trauma results in immunological dysfunction in patients owing to oxidative stress (3). Surgical stress often leads to postoperative immunosuppression resulting from the intricate interplay of various hormones (particularly adrenal corticosteroids), cytokines, and acute-phase reactants. This immunosuppression can substantially increase the likelihood of postoperative infections and complications, potentially extending recovery time and hospital stay. The intensity and duration of immunosuppression may vary based on factors, such as the extent of surgical trauma, patient age, and pre-existing health conditions (4,5). Recent progress in minimally invasive techniques has improved outcomes and shortened recovery periods. Laparoscopic surgery is expected to cause less immune impairment than abdominal surgery due to its association with reduced tissue damage (6).

Several methods are available to evaluate the postoperative inflammatory response, including white blood cell (WBC) count, neutrophil count, platelet count, lymphocyte count, neutrophil/lymphocyte ratio (NLR), platelet/lymphocyte ratio (PLR), and delta neutrophil index (DNI). These approaches are both simple and cost-effective (7). The delta neutrophil index is a measure of the proportion of immature granulocytes to neutrophils. Recent studies have indicated that the delta neutrophil index serves as an indicator of the inflammatory response and oxidative stress and plays a role in early prediction (8).

The aim of our study was to evaluate the inflammatory response in abdominal, vaginal, and laparoscopic hysterectomy techniques using complete blood count (CBC) parameters and to demonstrate the role of the delta neutrophil index in hysterectomy types.

METHODS

Total of 251 patients who underwent hysterectomy in the Gynecology and Obstetrics Clinic of our hospital, a tertiary center, between 2019 and 2024 were participated in this study. Ethics committee approval was obtained from the Ankara Bilkent City Hospital Ethics Committee No. 2. (Approval No: 24-639). Our study is a retrospective observational cohort study.

Female patients aged 18-70 years who underwent abdominal, vaginal and laparoscopic hysterectomy for benign gynecologic causes were included in our study. Benign gynecological causes were defined as abnormal uterine bleeding (AUB), endometrial pathologies, myoma uteri, and uterine desensus. Hysterectomy for postpartum hemorrhage, subtotal hysterectomy, hysterectomy for tubo-ovarian abscess, deep pelvic endometriosis, and hysterectomy for uterine or ovarian malignancies were excluded. In addition, patients with chronic inflammatory diseases, those already diagnosed with another organ malignancy, those with infections, corticosteroid users, anticoagulant users, diabetes and those with rheumatologic diseases were excluded.

The patients were divided into three groups: abdominal hysterectomy (AH), vaginal hysterectomy (VH), and laparoscopic hysterectomy (LH). Patients' age, body mass index (BMI), parity, gravida, operative indications, operation time, operative notes (with or without oophorectomy), and hospital stay were retrospectively investigated and recorded. CBC results (WBC, NLR, PLR, and DNI) of the patients before the operation, at the 6^{th} hour after the operation and at the 24^{th} hour after the operation were compared separately for the three groups. In our clinic, CBC checks are performed at the 6^{th} and 24^{th} hour after all hysterectomy operations, and patients without complications are discharged after 24 hours. These markers (WBC, NLR, PLR and DNI) are tested automatically as part of a standard complete blood count.

Statistical analyses were performed using SPSS version 21.0 (IBM Corp., Armonk, NY, USA). The Kolmogorov–Smirnov test was used to assess data normality. Normally distributed data are expressed as mean ± standard deviation. In contrast, non-parametric data were expressed as medians and interquartile ranges. One-way ANOVA and Kruskal–Wallis tests were used for intergroup comparisons. Repeated measures analysis of variance (ANOVA) were used to examine changes in data over time. The chi-squared test was used to compare categorical data. Statistical tests were considered significant at a P-value <0.05, whereas post-hoc correction tests were considered significant at a P-value <0.017 (0.05/3).

RESULTS

Of the 251 cases included in this study, 82 (32.7%) underwent LH, 85 (33.9%) underwent AH, and 84 (33.5%) underwent VH operations. While the mean age of all cases was 55.5 ± 9.0 years, the median values for gravida and parity were 3 (2) and 3 (1), respectively. The mean BMI value of all cases was 27.5 ± 3.5 kg/m^2. Of the patients, 127 (50.6%) were menopausal. When surgical indications were examined, surgery was performed for AUB in 125 cases (49.8%), pelvic mass in 40 cases (15.9%), and uterine decensus in 86 cases (34.3%). Uni- or bilateral salpingo-oophorectomy was performed in 140 (55.8%) patients. The mean operative time was 148.5 ± 44.3 minute. The postoperative hospital stay was 3 (2) days.

The demographic characteristics of the LH, AH, and VH groups are presented in Table 1. There were no significant differences between the groups in terms of gravida, parity, or BMI (P>0.05). However, the age and rate of menopausal patients in the VH group were higher than those in the LH and AH groups (P<0.05). There was no significant difference in the age and rate of menopausal patients between the LH and AH groups (P>0.017). From the perspective of surgical indications, while the most common indication in the LH and AH groups was AUB, all the patients in the VH group underwent surgery due to uterine desensus. There was a significant difference between the groups in terms of simultaneous uni- or bilateral salpingo-oophorectomy (P<0.05). The rate of simultaneous uni- or bilateral salpingo-oophorectomy was lower in the VH group than that in the LH and AH groups, whereas there was no difference between the LH and AH groups (P>0.017). However, there was a significant difference between the groups in terms of operation time (P<0.05). The operation time was longest in the LH group and shortest in the AH group. In contrast, there were no significant differences between the LH, AH, and VH groups based on postoperative hospital stay (P = 0.06).

The preoperative and postoperative serum CBC parameters of the LH, AH, and VH groups are presented in Table 2. Except for the postoperative 6th hour, which was significantly lower in the VH group than in the LH and AH groups (P<0.01), the LH, AH, and VH groups did not differ significantly based on the preoperative and postoperative 24th hour serum WBC levels (P>0.05). The change in WBC count over time revealed that the serum WBC count increased significantly at the 6th hour postoperatively in all the groups (P<0.01). The serum WBC count decreased significantly in the LH and AH groups at the 24th hour postoperatively than at the 6th hour postoperatively (P<0.01). Serum WBC count increased in the VH group at the 24th hour postoperatively than at the 6th hour postoperatively; however, this difference was not significant (P = 0.54). Overall, the change in the serum WBC count over time was significant in all groups (P<0.01) (Table 2).

The serum NLR did not differ significantly between the LH, AH, and VH groups preoperatively (P = 0.15). In contrast, serum NLR levels differed significantly between the LH, AH, and VH groups at 6th and 24th hours (P < 0.05). While serum NLR was significantly higher at

Table 1. Demographic characteristics of the total laparoscopic, abdominal, and vaginal hysterectomy groups.

Characteristics	LH group (n = 82)	AH group (n = 85)	VH group (n = 84)	P value
Age (years)	52.8 ± 7.3	50.6 ± 6.3	63.1 ± 7.8	<0.01
Gravida	3 (2)	3 (2)	3 (1)	0.10
Parity	2 (1)	3 (1)	3 (1)	0.15
BMI (kg/m^2)	27.5 ± 3.5	27.4 ± 4.2	27.6 ± 2.7	0.92
Menopause Yes No	 28 (11.2) 54 (21.5)	 21 (8.4) 64 (25.5)	 78 (31.1) 6 (2.3)	<0.01
Surgical indications AUB Pelvic mass POP	 67 (26.7) 13 (5.2) 2 (0.8)	 58 (23.1) 27 (10.7) 0 (0.0)	 0 (0.0) 0 (0.0) 84 (33.5)	-
Uni- or bilateral salpingo-oopherectomy Yes No	 70 (27.9) 12 (84.8)	 60 (23.9) 25 (10.0)	 10 (4.0) 74 (29.5)	<0.01
Operative time (min)	175.9 ± 53.6	125.7 ± 33.9	144.7 ± 25.6	<0.01
Postoperative hospital stay (day)	3 (2)	3 (1)	3 (2)	0.06

Data are presented as the mean ± standard deviation, median (interquartile range), or n (%).
* One-way ANOVA, Kruskal–Wallis, and chi-square tests were used for intergroup comparisons.
Abbreviations: AH, abdominal hysterectomy; AUB, abnormal uterine bleeding; BMI, body mass index; LH, laparoscopic hysterectomy; VH, vaginal hysterectomy.

Table 2. Preoperative and postoperative serum complete blood count parameters in the total laparoscopic hysterectomy, abdominal hysterectomy, and vaginal hysterectomy groups.

CBC Parameters		LH (n = 82)	AH (n = 85)	VH (n = 84)	P*
White blood cell count (x 10^3/μL)	Preoperatively	6.8 ± 1.9	6.9 ± 2.1	6.7 ± 1.7	0.75
	6th hour postoperatively	13.4 ± 3.8	14.2 ± 3.7	11.9 ± 4.1	<0.01
	24th hour postoperatively	11.0 ± 3.4	11.4 ± 3.3	12.1 ± 3.5	0.15
	Pα	<0.01	<0.01	<0.01	
Neutrophil-to-lymphocyte ratio	Preoperatively	2.5 ± 1.0	2.4 ± 1.1	2.2 ± 0.8	0.15
	6th hour postoperatively	16.5 ± 9.6	19.2 ± 9.1	10.6 ± 6.4	<0.01
	24th hour postoperatively	10.3 ± 7.5	7.9 ± 5.8	12.9 ± 6.8	<0.01
	Pα	<0.01	<0.01	<0.01	
Platelet-to-lymphocyte ratio	Preoperatively	159.9 ± 50.8	176.4 ± 68.6	139.8 ± 45.8	<0.01
	6th hour postoperatively	338.6 ± 173.7	416.2 ± 208.8	278.8 ± 101.4	<0.01
	24th hour postoperatively	271.5 ± 174.5	236.1 ± 128.5	232.9 ± 125.4	0.12
	Pα	<0.01	<0.01	<0.01	
Delta neutrophil index	Preoperatively	0.3 ± 0.5	0.4 ± 0.7	0.3 ± 0.6	0.54
	6th hour postoperatively	0.9 ± 1.2	1.4 ± 2.0	1.1 ± 1.7	0.23
	24th hour postoperatively	0.8 ± 1.4	0.6 ± 1.4	1.0 ± 1.6	0.22
	Pα	<0.01	<0.01	<0.01	

Data are presented as the mean ± standard deviation, median (interquartile range), or n (%).
*One-way ANOVA variance was used to compare the TLH, AH, and VH groups.
αRepeated-measures analysis of variance (ANOVA) was used to examine changes in complete blood count levels over time.
AH: Abdominal hysterectomy; LH: Laparoscopic hysterectomy; VH: Vaginal hysterectomy.

the 6th hour in the AH group than in the LH and VH groups (P < 0.01), serum NLR level was significantly lower at the 24th hour in the AH group than in the LH and VH groups (P < 0.01). The change in serum NLR levels over time revealed that serum NLR levels increased significantly at the 6th hour postoperatively in all the groups (P < 0.01). The serum NLR levels decreased significantly at the 24th hour postoperatively than at the 6th hour postoperatively in all groups (P < 0.01). Overall, the change in serum NLR over time was significant in all groups (P values < 0.01) (Table 2).

Except for the postoperative 24th hour, in which the difference between the LH, AH, and VH groups was not significant (P = 0.12), serum PLR levels were significantly lower in the VH group than in the LH and AH groups preoperatively and at 6th hour postoperatively (P < 0.01). The change in serum PLR levels over time revealed that serum PLR levels increased significantly at the 6th hour postoperatively in all groups (P < 0.01). The serum PLR levels decreased significantly at the 24th hour postoperatively than at the 6th hour postoperatively in all groups (P < 0.01). Overall, the change in serum PLR over time was significant in all the groups (P < 0.01) (Table 2).

There were no significant differences in serum DNI levels between the LH, AH, and VH groups preoperatively and at the 6th and 24th hours postoperatively (P = 0.54, 0.23, and 0.22, respectively). The change in serum DNI levels over time revealed that serum DNI levels increased significantly at the 6th hour postoperatively in all groups (P < 0.01). Serum DNI levels decreased significantly in the AH group at the 24th hour postoperatively than at the 6th hour postoperatively (P < 0.01). While serum DNI level decreased in the LH and VH groups at the 24th hour postoperatively than at the 6th hour postoperatively, these differences were not significant (P values were 0.52 and 0.60, respectively). Overall, the change in serum DNI levels over time was significant in all groups (P values < 0.01) (Table 2).

DISCUSSION

In our study, we evaluated the inflammatory response in abdominal, vaginal, and laparoscopic hysterectomy techniques using complete blood count parameters. In patients who underwent VH, higher age, a higher proportion of postmenopausal patients, fewer previous

surgeries, and fewer uni-or bilateral salpingo-oophorectomy were observed. The LH group had the longest operation time, while the AH group had the shortest. According to the results of the comparison of WBC, NLR, PLR, and DNI between the groups at preoperative, 6th hour postoperatively, and 24th hour postoperatively, all markers increased at 6th hour postoperatively compared to preoperative levels and decreased at 24th hour postoperatively compared to 6th hour postoperatively in all groups. However, all markers were higher in the AH group compared to the VH and LH groups at 6th hour postoperatively (although this increase was not significant in the DNI group, P=0.23). In the VH group, WBC, NLR, and PLR were lowest at 6th hour postoperatively. DNI levels did not differ significantly between the groups at preoperative, 6th hour postoperatively, or 24th hour postoperatively.

Abdominal, vaginal, and laparoscopic hysterectomy techniques have been used for a long time and have been compared many times in the literature. Although some studies do not report a higher mean age in VH patients (9), we found a higher mean age in the VH group in our study. We believe that this situation is also the reason why we identified more patients in menopause in the VH group. We also found that uterine descent was a frequent reason for hysterectomy in the VH group. Consequently, our findings can be explained by the development of uterine descent due to increased connective tissue weakness that occurs with older age in the VH group. Furthermore, consistent with the literature, we found that unilateral or bilateral salpigoophorectomies were less frequently performed in the VH group due to the difficulty of surgical technique (9).

Data on the comparison of operation times in hysterectomies are unclear. In one study, abdominal, vaginal, and laparoscopic hysterectomies were compared, and the shortest operation time was found in the VH group, while the longest operation time was found in the LH group (10). Several other studies have demonstrated similar results (11,12,13). These studies attributed the long surgical times in the LH group to lack of surgical experience and the time required for the assembly and setup of laparoscopic equipment. Additionally, a meta-analysis comparing vaginal hysterectomy and laparoscopic hysterectomy, which included 1,618 patients and 18 studies, reported shorter operative times in the VH group (14). In our study, we found the shortest operative time in the AH group and the longest in the LH group. We hypothesize that this is due to surgical experience, based on the ratio of hysterectomy types performed at our hospital.

Surgical trauma triggers a stress response and leads to an inflammatory response. After surgery, leukocyte and neutrophil counts increase, while lymphocytes and platelets decrease (3). Many studies have reported less tissue damage and immunological responses in laparoscopic surgeries compared to open surgeries (1,15, 16). WBC, NLR, and PLR are used as markers of inflammation (1). Özsürmeli et al. compared the changes in these inflammatory markers at the preoperatively and 24th hour postoperatively in patients undergoing LH and AH (1). They found that WBC, NLR, and PLR levels increased at 24th hour postoperatively in both groups. However, they reported that this increase was significantly higher in the AH group than in the LH group (1). Unlike them, in our study, we also investigated patients in the VH group in addition to the AH and LH groups. We also included the 6th hour postoperatively levels of WBC, NLR, and PLR. Our findings revealed that WBC, NLR, and PLR values increased at 6th hour postoperatively in all groups, then decreased at 24th hour postoperatively, but were still higher than preoperatively at 24th hour postoperatively. Although we could not demonstrate a clear significant difference between the groups in the postoperative 24th hour levels of these markers, the postoperative 6th hour levels were significantly different. We found that WBC, NLR, and PLR values at 6 hours postoperatively were highest in the AH group and lowest in the VH group. Although the AH group had the shortest operative time, the inflammatory response was highest in this group. This suggests that the role of surgical time in tissue damage is unimportant. Furthermore, despite being an open procedure, VH had the lowest inflammatory response. We believe that this is because, compared to AH and LH, VH has the least contact with other abdominal tissues such as the intestines, and therefore there are fewer cytokines and immunomodulators that can be secreted from these tissues.

DNI appears to be a marker that has been increasingly researched recently and whose importance is growing day by day. Some studies have reported that it is an indicator of inflammatory response (8), while others have suggested that it is a prognostic biomarker of the infectious process (17). However, definitive results have not yet been established. There are currently no studies in the literature comparing DNI between different types of hysterectomy. Therefore, our study is the first of its kind. Our findings show that DNI, like other markers, increases at 6th hour postoperatively and then decreases at 24th hour. However, DNI did not show a significant difference between the AH, VH, and LH groups. Therefore, we believe that the role of DNI in the inflammatory response is limited. The main limitation of our study is its retrospective nature, but the sufficient sample size and the reliability of our medical records are our strengths.

CONCLUSION

In conclusion, the highest postoperative inflammatory response was observed in the AH group, while the lowest response was

observed in the VH group. We found that LH patients had an average inflammatory response, and we believe that the findings of other studies indicating less tissue damage are open to debate. Therefore, further studies are needed in the future. Although DNI increased during the postoperative inflammatory process, there was no difference between the AH, LH, and VH groups.

Ethics Approval: Ethics committee approval was obtained from the Ankara Bilkent City Hospital Ethics Committee No. 2. (Approval No: 24-639).

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