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RESEARCH ARTICLE

Does the Preoperative Platelet-to-Lymphocyte Ratio Affect the Conversion from Laparoscopic Appendectomy to Open Surgery?

Laparaskopik Apendektomide Açığa Geçişte Preoperatif Platelet Lenfosit Oranının Etkisi var mı?

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ABSTRACT

Aim: Acute appendicitis (AA) is the most common cause of acute abdominal pain and emergency surgery worldwide. This study aimed to evaluate the effect of the preoperative platelet-to-lymphocyte ratio (PLR) on the conversion from laparoscopic to open appendectomy.

Method: This study retrospectively evaluated patients with AA who were hospitalized in the general surgery clinic between September 2015 and September 2020. The study included patients who underwent laparoscopic appendectomy under the same surgical team and those who required conversion to open surgery.

Results: During the study period, a total of 389 patients were followed and treated for AA in our clinic. Laparoscopy was initiated in 117 patients. While laparoscopic exploration alone was performed in four patients, conversion was done in 13 patients (11%), and laparoscopy was successfully completed in 100 patients (89%). Although increased preoperative white blood cell count was not a predictive factor for the conversion (p= 0.605), sex, age, elevated C-reactive protein levels, increased preoperative appendix diameter, higher body mass index, complicated AA, and increased preoperative PLR and neutrophil-to-lymphocyte ratio values were predictive factors affecting the conversion to open appendectomy (p values were 0.042, <0.001, 0.02, 0.014, 0.008, 0.011, <0.001, and 0.001, respectively). The sensitivity and specificity of PLR values for determining the conversion in the preoperative period were 76.9% and 84%, respectively, with a cutoff value of ≥190.56 (area under the curve: 0.853; confidence interval: 0.728-0.928).

Conclusion: Results showed that the preoperative PLR values, when evaluated together with other predictive parameters, are predictive factors for patients who will undergo laparoscopic appendectomy.

Keywords: Emergent surgery, acute appendicitis, laparoscopic appendectomy, conversion, platelet-to-lymphocyte ratio

ÖZ

Amaç: Akut apandisit (AA) dünyada akut abdominal ağrının en sık nedeni ve en sık acil cerrahi durumu AA'dır. Bu çalışmada preoperatif çalışılan platelet-lenfosit oranının (PLR) laparaskopik cerrahiden açığa geçiş üzerindeki etkisi araştırıldı.

Yöntem: Ekim 2015 ila Ekim 2020 tarihleri arasında genel cerrahi kliniğine AA tanısı ile yatırılan hastalar retropektif olarak değerlendirildi. Çalışmaya aynı cerrahi ekip tarafından laparoskopik cerrahi uygulanan ve açığa geçilme ihtiyacı olan hastalar dahil edildi.

Bulgular: Çalışma sürecinde kliniğimizde AA tanısı ile 389 hasta takip ve tedavi aldı. Yüz on yedi hastada cerrahiye laparoskopik başlandı. Dört hastaya sadece laparoskopik eksplorasyon uygulandı. On üç hastada (%11) açık cerrahiye geçilirken 100 hastada (%89) cerrahi laparoskopik olarak tamamlandı. Preoperatif dönemde artmış beyaz küre değerleri açığa geçiş için prediktif bir faktör olarak bulunmazken (p=0,605), cinsiyet, yaş, artmış preoperatif C-reaktif protein, artmış apendiks çapı, yüksek vücut kitle indeksi değerleri, komplike AA olguları ve artmış preoperatif PLR ve nötrofil lenfosit oranları değerleri açık apendektomiye geçişte etkili prediktif faktörler olarak bulundu (sırasıyla p değerleri: 0,042;<0,001;0,02;0,014;0,008;0,011;<0,001 ve 0,001). Laparoskopik cerrahiden açık cerrahiye geçişin tespit edilmesinde PLR'nin cut-off değeri ≥190,56 iken duyarlılığı ve özgüllüğü sırasıyla %76,9 ve %84'tü (eğri altında kalan alan: 0,853; konfidens interval: 0,728-0,928).

Sonuç: Preoperatif dönemde bakılan kan parametrelerinden hesaplanan PLR değerleri, diğer prediktif faktörlerle beraber incelendiği zaman laparoskopik cerrahiye gidecek hastalarda açığa geçişte prediktif faktördür.

Anahtar Kelimeler: Acil cerrahi, akut apandisit, laparoskopik apendektomi, açığa geçiş, platelet-lenfosit oranı

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Introduction

Acute appendicitis (AA) is the most common cause of acute abdominal pain and emergency surgery worldwide. Presently, surgery is the most effective treatment for AA.[1,2,3] Compared with traditional open appendectomy as described by McBurney, laparoscopic appendectomy has started to come to the forefront and become a basic laparoscopic surgical intervention since Semm first described it in 1983.[2,4,5] Its advantages include shorter hospital stay, less postoperative pain, diagnosis of other causes of acute abdomen, and faster recovery.[1,6]

While the rate of conversion to open surgery ranges from 0% to 17%[7], the increasing experience of surgeons in laparoscopic surgery has decreased this range further. However, the need for conversion from laparoscopic to open surgery is still an important concern for surgeons[5] because of the following reasons: prolonged operation time and hospital stay, the emergence of the need for additional incisions, and increased rates of developing postoperative wound infections.[1] The most important factors for conversion include age, male sex, obesity, intra-abdominal abscess formation, the presence of perforation, and presence of adhesions from previous surgeries.[1] Additionally, the surgeon's experience is also an important consideration for conversion.[8]

A wide variety of blood parameters, such as neutrophil-to-lymphocyte ratio (NLR), mean platelet volume, platelet count, and platelet-to-lymphocyte ratio (PLR)[9,10], have been used to diagnose AA and identify complications. Similarly, blood parameters, such as preoperative white blood cell (WBC), C-reactive protein (CRP), and NLR values, have also been used to determine the need for conversion.[1,7]

This study aims to evaluate the effect of preoperative patient characteristics on the conversion and the weight of preoperative NLR and PLR in identifying patients with a high probability of conversion.

Materials and Methods

This study was approved by Kahramanmaraş Sütçü İmam University, Faculty of Medicine Human Research Ethical Committee (protocol number: 356, date: 14/10/2020, session number: 2020/19, decision no: 01). The study evaluated the records of patients admitted to the emergency department due to acute abdomen and those hospitalized in the general surgery clinic with a diagnosis of AA between September 2015 and September 2020. AA cases who underwent laparoscopic surgery (successfully completed laparoscopy and converted to open surgery) performed by the same surgical team in Kahramanmaraş Sütçü İmam University, Department of General Surgery and those who required conversion to open surgery were included. Contrarily, we excluded from this study patients who directly underwent open appendectomy, who were not operated and followed with medical treatment, who did not have AA and were undergoing only laparoscopic exploration, and who had missing data.

We categorized the patients in the study into two groups: those whose procedures were completed laparoscopically (Group LA) and those who required conversion to open surgery (Group Con). We then retrospectively evaluated the demographic data of the patients (age, height, weight, manually calculated body mass index [BMI], and sex), preoperative routine blood count parameters (PLR and NLR values manually calculated from WBC, platelet, neutrophil, and lymphocyte values), CRP levels among preoperative routine biochemical parameters, the presence of complicated AA, and the number of laparoscopic appendectomy cases (Group LA and Group Con). We obtained patient data from epicrisis forms and computer records of preoperative laboratory and postoperative pathology results.

Statistical Analysis

We calculated the study's power analysis using the G-power 3.0.10 software. The total number of patients in the two independent groups was 102, with a statistical power size of 0.8 and an effect size of 0.5 in a single preoperative measurement.

We performed statistical analysis using the IBM Statistical Package for Social Sciences (SPSS) version 20 software. We checked the normal distribution between independent groups using the Shapiro-Wilk test, whereas we used the Mann-Whitney U test to evaluate the numerical data according to data conformity to normal distribution and the chi-square test to evaluate categorical data. We performed receiver operating characteristic (ROC) analysis to evaluate the effect of PLR, WBC, NLR, and CRP values and univariate analysis to identify the factors that might affect the conversion to open surgery. Additionally, we performed multivariate analysis to determine predictive factors. We expressed numerical values as median (minimum-maximum values), and categorical values as number (n) and percentages (%). A p value of <0.05 was considered statistically significant.

Results

A total of 389 patients were followed and treated for AA in our clinic during the study period. Seventy-one of these patients had uncomplicated AA and received medical treatment. Of the patients included, 201 patients underwent open surgery, wherein 117 patients initially underwent laparoscopy. Four patients underwent only laparoscopic exploration. Contrarily, 13 patients were in Group Con

(11%) and 100 patients in Group LA (89%) (Figures 1 and 2). The conversion was due to colonic injury in two patients, bleeding in three patients, and difficulty in appendix exploration in eight patients. The number of open and laparoscopic appendectomies (those completed laparoscopically and those converted to open surgery) performed by years is shown in Figure 2.

Of the 113 patients who met the inclusion criteria, 66 (58.4%) were male and 47 (41.6%) female. The median age of male and female patients was 28 (18-75) and 31 (18-66) years, respectively (p=0.426). Conversion was recorded in four male patients and nine female patients (p=0.042) (Table 1).

Table 1 presents the demographic data of patients, the presence of complicated AA in the preoperative period, and laboratory results in Group LA and Group Con.

Although previous studies reported that preoperative WBC values affect the conversion, univariate and multivariate analyses revealed that increased preoperative WBC values were not a predictive factor in the conversion to open appendectomy (p value =0.605). Contrarily, sex, age, CRP values, preoperative appendix diameter, BMI values, complicated AA on preoperative radiological imaging, and increased preoperative PLR and NLR values were predictive factors significantly affecting the conversion (p values were

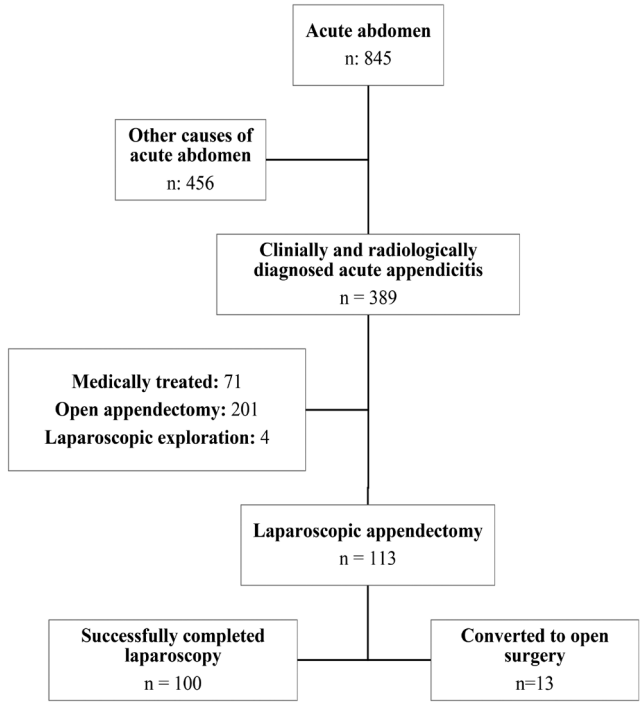

Figure 1. Flowchart of the study design

Table 1. Demographic characteristics (sex, age, BMI levels), cases characterized as either complicated or uncomplicated AA according to the preoperative imaging methods, and preoperative laboratory results

		Successfully completed laparoscopic appendectomy	Converted to open appendectomy	p values
Sex	Male	55 (55%)	11 (84.6%)	
	Female	45 (45%)	2 (15.4%)	0.042*
Total		100 (100%)	13 (100%)	
Preoperative imaging modalities	CAA	27 (27%)	8 (61.5%)	
	UAA	73 (73%)	5 (38.5%)	0.016*
Total		100 (100%)	13 (100%)	
Age (years)		28 (18-68)	52 (18-75)	0.014*
WBC count (/mm³)		13,160 (6,930-25,180)	14,980 (1,870-25780)	0.349
NLR		5.05 (1.06-62.79)	12.45 (2.33-62.79)	0.005*
PLR		141.54 (37.94-1,324.14)	331.58 (100.38-1,324.14)	<0.001*
CRP		17.9 (3.02-349)	59.8 (13-349)	0.008*
Preoperative appendix diameter (mm)		10 (6-18)	11 (6-18)	0.048*
Hospitalization (day)		1 (0-5)	4 (1-24)	<0.001*
BMI (kg/m²)		22.91 (15.62-35.26)	26.18 (19.02-30.85)	0.006*

*p<005; statistically significant

WBC: White blood cell count, CRP: C-reactive protein, PLR: Platelet-to-lymphocyte ratio, NLR: Neutrophil-to-lymphocyte ratio, BMI: Body mass index, CAA: Complicated acute appendicitis, UAA: Uncomplicated acute appendicitis

0.042, <0.001, 0.02, 0.014, 0.008, 0.011, <0.001, and 0.001, respectively).

ROC Curve Analysis of Preoperative WBC, CRP, PLR, and NLR values in Patients who Required Conversion from Laparoscopy to Open Appendectomy

Results showed that the sensitivity and specificity of preoperative PLR values for determining the conversion were 76.9% and 84%, respectively, with a cutoff value of ≥190.56 [area under the curve (ARUC): 0.853; confidence interval (CI): 0.728-0.928]. The sensitivity and specificity of preoperative NLR values were 69.2% and 65%, respectively, with a cutoff value of ≥6.61 (ARUC: 0.741; CI: 0.574-0.908) (Figure 3 and Table 2).

Discussion

The concept of laparoscopic surgery may be attributed to Ebu'l Kasım El-Zehravi who described vaginal examination by directing light to a straight imaging instrument. However, Kelling performed the first laparoscopy in 1901 and defined this technique as "coelioscopy" through an evaluation of the intra-abdominal organs of a dog.[11,12] Thanks to technological advancements, laparoscopic surgery or minimally invasive surgery has become the preferred treatment.[13] After Kurt Semm, a German gynecologist, performed laparoscopic appendectomy in 1983, the technique has taken its place as one of the most important laparoscopic surgical techniques.[6] Particularly during 2020 coronavirus disease-19 outbreak, there has been a significant decrease in surgical appendectomy cases. During this period, nonoperative treatment was preferred as the first-line treatment option, particularly in cases with uncomplicated AA.[14,15]

Laparoscopic surgery has many proven advantages over conventional open surgery, including a more acceptable aesthetic appearance thanks to smaller incisions[6], shorter hospital stay, and less need for analgesics.[1]

Although the rate of conversion from laparoscopic appendectomy to open surgery only ranges from 0% to

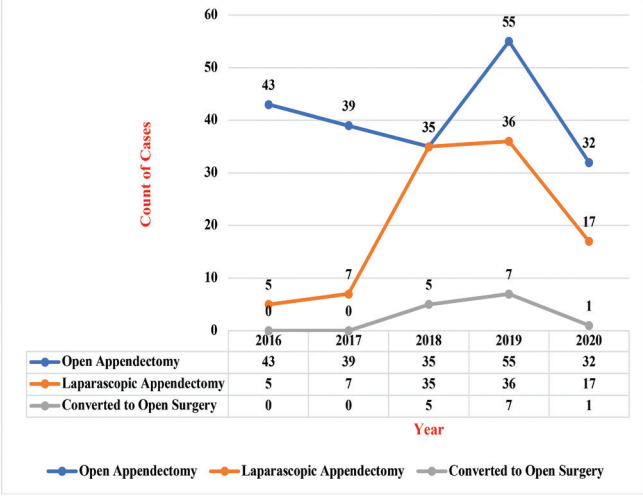

Figure 2. Distribution of the appendectomies according to the study period (October 2016-October 2020)

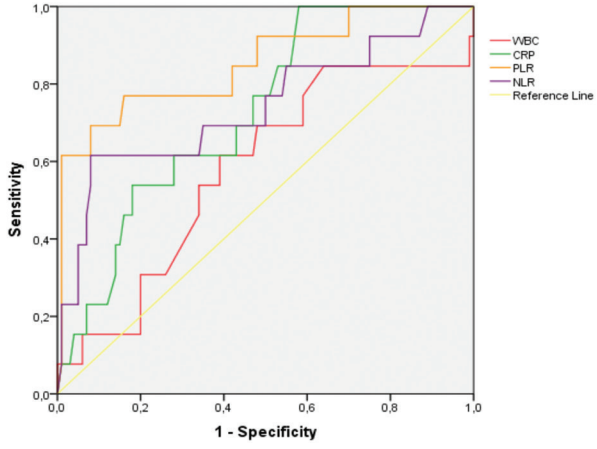

Figure 3. The receiver operating characteristic (ROC) curve of the CRP, NLR, PLR, and WBC levels for conversion cases

WBC: White blood cell count, CRP: C-reactive protein, PLR: Platelet-to-lymphocyte ratio, NLR: Neutrophil-to-lymphocyte ratio

Table 2. The receiver operating characteristic (ROC) curve analysis of the CRP, NLR, PLR, and WBC levels for conversion from laparoscopic to open appendectomy cases

	ARUC	Asymptotic 95% confidence interval		Sensitivity (%)	Specificity (%)	Cut off value	p value
		Lower bound	Upper bound				
WBC (/mm³)	0.580	0.407	0.753	69.2	52	13480	0.349
CRP	0.727	0.602	0.851	76.9	57	22.85	0.008*
PLR	0.853	0.728	0.978	76.9	84	190	<0.001*
NLR	0.741	0.574	0.908	69.2	65	6.61	0.005*

WBC: White blood cell count, CRP: C-reactive protein, PLR: Platelet-to-lymphocyte ratio, NLR: Neutrophil-to-lymphocyte ratio, ARUC: Area under curve

17%[16], the increase in treatment costs, need for additional incision, and prolonged duration of hospital stay for patients who require the conversion should still be noted.[17] Previous studies have identified many factors affecting the conversion to open surgery (e.g., preoperative high CRP levels, sex, obesity, abscess formation with AA, presence of complicated AA in the preoperative period, lack of experience in laparoscopic surgery, bleeding, and iatrogenic organ injury).[3,6,7,16,18,19,20,21] Consistent with previous findings, the present study has identified the presence of complicated AA, uncontrolled bleeding, and iatrogenic cecal perforation as the primary reasons in determining the need for conversion. Moreover, similar to previous studies, we observed that the length of stay in hospitals was longer in patients who required the conversion.

Because NLR is a more sensitive test compared to leukocyte count, our study suggests that other blood parameters can also be used in the preoperative diagnosis of infectious (e.g., AA) and non-infectious (e.g., malignancies) diseases.[9,22,23] Additionally, Pehlivanlı and Aydin[9] reported that PLR values were a valuable marker in the preoperative diagnosis of AA based on these inflammatory markers. They also suggested that the increase in PLR values were useful in differentiating normal appendix from an inflamed appendix and were a predictive factor in the preoperative diagnosis of uncomplicated and complicated AA.[9] Similarly, Yazar et al.[24] found that when used together with other blood parameters, NLR and PLR had a diagnostic value of 90.5%. Similarly, Çınar et al.[25] showed that NLR and PLR values were reported to be specific indicators in the diagnosis of AA.

Apart from the preoperative diagnosis, the use of blood parameters (such as CRP and NLR) as a predictive factor for conversion from laparoscopic to open surgery has formed the hypothesis of the present study that preoperative PLR values can also determine the need for conversion. The findings obtained from the study confirm this. Furthermore, when the cutoff value is taken as ≥190, the sensitivity and specificity of preoperative PLR as a new parameter in addition to previously reported predictive factors reached 72.9% and 84%, respectively, showing that PLR is an effective factor for conversion.

Study Limitations

The primary limitation of the present study is its retrospective design. Secondly, compared with hospitals providing secondary care, the number of appendectomies performed annually in our tertiary center is lesser than in other studies. However, power analysis has shown that our data is sufficient. Since our hospital provides tertiary general surgery specialization training, physicians with less surgical experience work in our hospital. Therefore, our rates of conversion to open surgery are relatively higher (10%) than other hospitals that have more experienced surgeons. Nevertheless, a review of PubMed and other databases has revealed that our study is the first to investigate preoperative PLR value as a predictive factor for the conversion from laparoscopic to open surgery. This is the most important advantage of our study. Therefore, we believe that surgeons who want to perform laparoscopic surgery, particularly in rural areas that lack of imaging methods, can use the PLR values from complete blood count in identifying patients for laparoscopic appendectomy.

Conclusion

In conclusion, when evaluated together with other predictive parameters, higher preoperative PLR value is a useful parameter in determining cases with a high possibility of conversion, anticipating possible complications that may occur because of the conversion, and deciding whether an open appendectomy before surgical administration is needed.

Ethics

Ethics Committee Approval: This study was approved by Kahramanmaraş Sütçü İmam University, Faculty of Medicine Human Research Ethical Committee (protocol number: 356, date: 14/10/2020, session number: 2020/19, decision no: 01).

Informed Consent: Taken form all patients for surgical intervention

Peer-review: Externally peer reviewed.

Authorship Contributions

Surgical and Medical Practices: M.B.B., F.M.Y., Concept: M.B.B., F.M.Y., Design: M.B.B., F.M.Y., Data Collection or Processing: M.B.B., Analysis or Interpretation: M.B.B., F.M.Y.,

Literature Search: M.B.B., Writing: M.B.B., F.M.Y.

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