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Comparison of Hematological Markers between Right Ureteral Stone and Acute Appendicitis

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Abstract: Referrals to emergency services are frequently made for acute appendicitis and renal colic. This conundrum of patients with acute appendicitis and right ureteral stones frequently presents itself to emergency physicians. The hematological parameters of patients suffering from acute appendicitis and right ureteral stones were compared in this study. From May 2022 to April 2023 the patients who applied to emergency department were reviewed retrospectively. Of these patients, age, sex, complete blood test results including white blood cell, procalcitonin and C-reactive protein were recorded. The platelet to lymphocyte ratio and the neutrophil to lymphocyte ratio were calculated by dividing the platelet count by the lymphocyte, and the neutrophil count by the lymphocyte count, respectively. We used the receiver operating characteristic curves to assess the diagnostic efficacy of hematological markers. There were 106 patients in the study. The mean age of the patients was 43.83 ± 15.82 years. The significant difference was found for age, white blood cell, neutrophil, lymphocyte, neutrophil to lymphocyte ratio, platelet to lymphocyte ratio and monocyte between groups. The white blood cell and neutrophil to lymphocyte ratio have the biggest area than the other parameters in the receiver operating characteristic curves. Patients with acute appendicitis have a high level of neutrophil to lymphocyte ratio, platelet to lymphocyte ratio than ureteral stones. Further studies are needed to define the diagnostic efficacy of hematological markers for acute appendicitis and ureteral stones.

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Introduction

At a lifetime risk of 8–6% for men and 6–7% for women, acute appendicitis (AA) is the most common infectious disease of the abdomen (Bom et al., 2021). Luminal obstruction caused by a variety of etiologies is linked to appendicitis. This is because bacterial overgrowth and increased mucus production cause wall tension, necrosis, and possible perforation (Mandeville et al., 2015). Right quadrant pain, rigidity in the abdomen, and periumbilicial pain radiating to the right lower quadrant are the current symptoms of AA patients. Based on a clinical assessment that includes a detailed patient history, physical examination, and laboratory results, an AA diagnosis can be made (Snyder et al., 2018). Regretfully, without imaging, surgical trainees and surgeons failed to make the correct clinical diagnosis in 44% and 43% of the patients based only on physical examination, medical history, and routine laboratory tests (Acute Abdominal Pain [AAP] Study Group, 2016).

On the other hand, renal colic, which causes lower back pain, nausea, and vomiting, is one of the most frequent urological emergencies. Right ureteral stones (rUS) and AA can be mistaken for one another due to the common symptoms (Acar et al., 2016). Medical professionals will require extra examinations, such as computed tomography and ultrasound. Computed tomography necessitates a specialist and involves radiation and contrast media hypersensitivity; an experienced sonographer may not always be available.

Aim

Physicians frequently struggle with symptoms that resemble those of patients with AA to terminal ureteral stones. Emergency physicians require data that are easily accessible and objective. We examined the hematological characteristics of AA and rUS patients in the emergency room.

Material and Methods

The patients who applied to the Emergency Department of Marmara University, Pendik Training and Research Hospital between May 2022 and April 2023 were retrospectively reviewed. Age, gender, complete blood test results including white blood cell (WBC), procalcitonin and C-reactive protein (CRP) were recorded. The platelet to lymphocyte ratio (PLR) and the neutrophil to lymphocyte ratio (NLR) were calculated by dividing the number of platelets by the number of lymphocytes and the number of neutrophils by the number of lymphocytes, respectively.
The normal hematological reference values for leukocytes, CRP, procalcitonin, neutrophils, platelets and lymphocytes were 4,000–10,000×10^6/l, 0–5 mg/l, 0–0.5 µg/l, 1,400–7,300×10^6/l, 150,000–440,000×10^6/l or 800–5,000×10^6/l.
Venous blood samples were collected by antecubital venipuncture and contained

ethylenediaminetetraacetic acid as an anticoagulant. A complete blood count was measured as a standard laboratory procedure. Patients who were diagnosed with a hematological disease, were receiving anticoagulant medications, or had an active infection were excluded from the study. Platelet to lymphocyte ratio and neutrophil to lymphocyte ratio were compared between AA and rUS. Receiver operating characteristic (ROC) curves were analysed to assess the diagnostic effectiveness of PLR, NLR, WBC, procalcitonin, CRP and lymphocytes in acute appendicitis. Distribution normality was analysed using the Kolmogorov-Smirnov test. The normal distribution variable was compared with the independent *t*-test and the others were compared with the Mann-Whitney U test. Data were expressed as mean ± standard deviation for age, white blood cells, neutrophils, lymphocytes, mean platelet volume, and mean platelet distribution width for the others, and $P<0.05$ with statistical significance. Statistical analyses were performed using the demo version of MedCalc Statistical Software version 17.6 (MedCalc Software, Ostend, Belgium; http://www.medcalc.org; 2017). The study protocol was approved by the Ethics Committee of Marmara University (clinical ethical approval No. 09.2023.1687).

Table 1 – Descriptive analysis of the groups, hematological and demographic parameters

	Group 1	Group 2	P
	mean + SD	mean + SD	
n, %	50 (47.16)	56 (52.83)	
Age	36.20 ± 14.80	50.64 ± 13.50	<0.0001
Lymphocyte	243.98 ± 99.93	177.64 ± 120.94	<0.0001
Neutrophil	1990.94 ± 981.78	659.43 ± 638.87	<0.0001
WBC	15122 ± 3641.83	90001.78 ± 3317.19	<0.0001
PDW	11.98 ± 1.69	12.13 ± 1.97	0.6800
MPV	10.34 ± 0.88	10.31 ± 0.87	0.8400
	median	median	
CRP	52	8.35	<0.0001
HG	14.35	13.75	0.0922
MCV	84.25	85.95	0.0960
Monocyte	1	0.6	<0.0001
NLR	7	3.0	<0.0001
Platelet	258	232	0.1066
PLR	1033.50	1393.50	0.0008
Procalcitonin	0.07	0.07	0.7736
RDW	13	12.85	0.6080

WBC – white blood cell; CRP – C-reactive protein; RDW – reticulocyte distribution width; MPV – mean platelet volume; HG – hemoglobin; MCV – mean corpuscular volume; NLR – neutrophil to lymphocyte ratio; PLR – platelet to lymphocyte ratio; PDW – platelet distribution width; SD – standard deviation

Results

There were 106 patients in the study. Of these patients, 52 were male and 54 were female. The mean age of the patients was 43.83 ± 15.82 years. The patients with AA and rUS were in Group 1 and 2 respectively. Table 1 shows the hematological parameters in each group. There was significant difference for age, WBC, neutrophil, lymphocyte, NLR, PLR and monocyte between groups.

The ROC curve analyses demonstrated that WBC and NLR have the biggest area than NLR, PLR, procalcitonin, neutrophil, lymphocyte (Figure 1). The area under the curve (AUC) of the hematological parameters can be seen in Table 2. There was significant difference between WBC and others except NLR. When comparing the NLR and the other parameters; significant difference was only between NLR and procalcitonin.

Discussion

The most frequent cause of acute abdominal pain and a common reason for referrals to emergency services is appendicitis. It makes up approximately 10% of all admissions to emergency services (Acar et al., 2016; Bom et al., 2021). The patients with abdominal pain accounted for 30% of those who were undiagnosed and approximately 5% of all hospitalizations (Acar et al., 2016). In most cases,

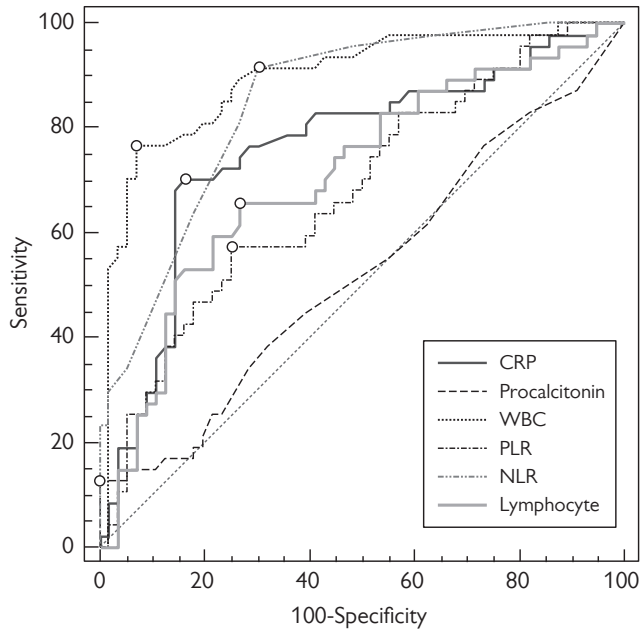

Figure 1 – The receiver operating characteristic of the hematological parameters.

Table 2 – Area under curve of the parameters and statistical difference between parameters

	AUC	SE	95% CI
CRP	0.762	0.0496	0.668 to 0.841
Procalcitonin	0.525	0.0580	0.424 to 0.624
WBC	0.895	0.0330	0.819 to 0.946
PLR	0.679	0.0530	0.579 to 0.767
NLR	0.850	0.0370	0.766 to 0.913
Lymphocyte	0.710	0.0521	0.612 to 0.795
	Difference between areas		**P**
WBC-NLR	0.0448		0.2817
WBC-CRP	0.1320		0.0131*
WBC-procalcitonin	0.3700		<0.0001*
WBC-PLR	0.2160		<0.0001*
WBC-lymphocyte	0.1850		<0.0001*
NLR-CRP	0.0874		0.1164
NLR-procalcitonin	0.3250		<0.0001*
NLR-PLR	0.1710		0.0202*
NLR-lymphocyte	0.1400		0.0503
PLR-CRP	0.0838		0.2528
PLR-procalcitonin	0.1540		0.0508
PLR-lymphocyte	0.0310		0.2777
CRP-procalcitonin	0.2380		<0.0001*
CRP-lymphocyte	0.0528		0.4518
Procalcitonin-lymphocyte	0.1850		0.0205*

AUC – area under curve; WBC – white blood cell; CRP – C-reactive protein; NLR – neutrophil to lymphocyte ratio; PLR – platelet to lymphocyte ratio; CI – confidence interval; SE – standard error; *statistically significant difference

appendicitis strikes in the second or third decade of life. Clinical manifestations include pain in the right lower quadrant, rigidity in the abdomen, and, in adults, radiating pelvic pain to the right lower quadrant. Physical examination findings in patients with AA include the psoas sign, obturator sign, and Rovsing sign.

CRP and the white blood cell count are common biomarkers for AA diagnosis. Renal colic is a sudden, acute pain condition that is typically diagnosed in emergency departments (Sönmez et al., 2021). The authors reported that 15–24 percent of the patients with AA are missed, and the negative appendectomy rate is 13–18 percent, which is higher than the ideal upper limit of 5 percent (Acute Abdominal Pain [AAP] Study Group, 2016; Sönmez et al., 2021). Renal colic is most common in men and peaks in the third and fifth decades of life. Painful episodes of acute renal colic are accompanied by an increase in intraluminal pressure due to ureteral obstruction. Prostaglandin and nitric oxide inflammation without inflammation are mediators linked to the pathogenic mechanism. Acute renal colic is commonly characterized by abdominal pain, low back pain, and hematuria (>10 erythrocytes/microscope

field), which can be mistaken for acute appendicitis. Consequently, more imaging techniques and laboratory testing are required for the diagnosis (Tasso et al., 1997).

Emergency department clinicians deal with this condition on a daily basis and attempt to distinguish between these two illnesses. With and without computed abdominal tomography imaging, the authors reported that the negative appendectomy rate was 5.17 and 17.9 percent, respectively (Tan et al., 2013). The most widely used imaging method for acute appendicitis is computed tomography (Bom et al., 2021). A number of organizations, including the National Cancer Institute, American Academy of Pediatrics, and American College of Radiology, advise patients to begin with ultrasonography (Smith et al., 2015; Depinet et al., 2016; Doniger and Kornblith, 2018). Certain inflammatory markers can demonstrate the process of acute appendicitis because it is linked to inflammation of the appendix vermiformis (Sönmez et al., 2021). Hematological markers that are known to predict the inflammatory process include WBC, RDW, MPV, neutrophil, and NLR. Numerous studies have made use of these inflammatory markers (Tanrikulu et al., 2014; Çalışkan, 2019; Kocaman et al., 2022; Velasco et al., 2023). Moreover, elevated RDW levels were discovered in a number of pathological circumstances (Tanrikulu et al., 2014; Sönmez et al., 2021). More cytokines during inflammation aid in the production of fresh platelets and neutrophils. The production of neutrophils causes a relative decrease in the number of lymphocytes. The MPV is a biological indicator of platelet activation that is connected to platelet morphology.

There were some limitations in this study. The retrospective design, which is associated with selection bias and incomplete data collection, is the main limitation. The small number of patients and single center data are the other limitations. None of the single clinical or laboratory parameters are sensitive or specific enough for diagnosis or exclusion of AA and rUS.

Conclusion

Patients with acute appendicitis and right ureteral stone apply to emergency department with similar symptoms. The hemogram parameters such as the WBC, PLR, NLR, lymphocyte, neutrophil and monocyte which are available in all clinics can be used for differential diagnosis. Prospective studies including large number of patients should be designed to define the diagnostic efficacy of these parameters.

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