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ORIGINAL

The performance of the inflammatory indexes in predicting double J catheter insertion necessity among children and adult patients with ureteral stone

Rendimiento de los índices inflamatorios en la predicción de la necesidad de inserción de catéter doble J en niños y adultos con cálculos ureterales

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Abstract

Objective: The present study was designed to examine the differences in NLR, PLR, and PNLR between two distinct patient groups, further examining their utility as diagnostic markers.
Materials and methods: Patients were then separated into two categories: Group 1 (those not require DJ catheter insertion) and Group 2 (those needed DJ catheter insertion). Factors such as patient age, gender, symptoms, diagnosis, hematological parameters, and some indexes (NLR, PLR, and PNLR) were thoroughly assessed.
Results: The research study featured 150 participants, split into two groups of 80 (Group 1) and 70 (Group 2) individuals. Despite average age differences, the distribution of ages was statistically significant. Group 1 had more children, while Group 2 contained more adults. Gender distribution between groups was not significantly different. Group 2 had larger mean stone sizes than Group 1. Stone location showed no significant variation between the groups. WBC and NEU were higher in Group 2, while LYM was higher in Group 1. There was no significant difference in MONO, PLT, and urea levels, but CRE level was higher in Group 2. NLR, PLR, and PNLR were also significantly higher in Group 2. Cut-off values for NLR, PLR, and PNLR had moderate to good predictive abilities. There was a positive correlation between stone size and PNLR index.
Conclusions: Our study demonstrates the predictive utility of hematological parameters (NLR, PLR, PNLR) in determining the need for DJ catheter placement in ureteral stone patients.

Key words: Ureteral stone, inflammatory index, neutrophil-lymphocyte ratio, platelet-lymphocyte ratio, platelet-neutrophil-lymphocyte ratio.

Resumen

Objetivo: El presente estudio se diseñó para examinar las diferencias en NLR, PLR y PNLR entre dos grupos distintos de pacientes, examinando además su utilidad como marcadores diagnósticos.
Materiales y métodos: Los pacientes fueron separados en dos categorías: Grupo 1 (los que no precisaron inserción de catéter DJ) y Grupo 2 (los que precisaron inserción de catéter DJ). Se evaluaron minuciosamente factores como la edad del paciente, el sexo, los síntomas, el diagnóstico, los parámetros hematológicos y algunos índices (NLR, PLR y PNLR).
Resultados: El estudio de investigación contó con 150 participantes, divididos en dos grupos de 80 (Grupo 1) y 70 (Grupo 2) individuos. A pesar de las diferencias de edad media, la distribución de edades fue estadísticamente significativa. En el Grupo 1 había más niños, mientras que en el Grupo 2 había más adultos. La distribución por sexos entre los grupos no fue significativamente diferente. El Grupo 2 tenía un tamaño medio de los cálculos mayor que el Grupo 1. La localización de los cálculos no mostró variaciones significativas entre los grupos. Los valores de WBC y NEU fueron superiores en el Grupo 2, mientras que los de LYM fueron superiores en el Grupo 1. No hubo diferencias significativas en los niveles de MONO, PLT y urea, pero el nivel de CRE fue superior en el Grupo 2. Los valores de NLR, PLR y PNLR también fueron significativamente superiores en el Grupo 2. Los valores de corte para NLR, PLR y PNLR tenían una capacidad predictiva de moderada a buena. Hubo una correlación positiva entre el tamaño del cálculo y el índice PNLR.
Conclusiones: Nuestro estudio demuestra la utilidad predictiva de los parámetros hematológicos (NLR, PLR, PNLR) para determinar la necesidad de colocación de catéter DJ en pacientes con cálculos ureterales.

Palabras clave: Cálculo ureteral, índice inflamatorio, cociente neutrófilos-linfocitos, cociente plaquetas-linfocitos, cociente plaquetas-neutrófilos-linfocitos

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Introduction

Ureteral stones represent a common and significant health problem, with global incidence rates that have been steadily rising over the past few decades. The lifetime risk of developing a ureteral stone is approximately 12% in men and 6% in women, reflecting a male predominance[1]. However, the occurrence varies by geographic location and population, influenced by factors such as age, sex, ethnicity, diet, and hydration status. Treatment of ureteral stones depends on several factors, including the size and location of the stone, the severity of symptoms, and the overall health status of the patient. In certain cases, small stones (<5mm) can often pass spontaneously with supportive care, which includes analgesia for pain management and hydration to facilitate stone passage. Patients are often advised to consume a high volume of fluids, and in some cases, medications known as alpha-blockers are prescribed to relax the muscles in the ureter, aiding the stone's passage[2]. For larger stones (>5mm), those causing significant symptoms, or stones that fail to pass spontaneously, more active interventions are required. These may include extracorporeal shock wave lithotripsy (ESWL), ureteroscopy with laser lithotripsy, and in severe cases, percutaneous nephrolithotomy (PCNL) or even open surgery. ESWL uses shock waves to break the stone into small pieces that can pass more easily, while ureteroscopy involves inserting a thin scope into the ureter to directly visualize and break up the stone using a laser[2,3].

Inflammation plays a vital role in the pathogenesis and progression of numerous diseases, including stone diseases. Various systemic markers of inflammation, such as Neutrophil to Lymphocyte Ratio (NLR), Platelet to Lymphocyte Ratio (PLR), and Platelet to Neutrophil to Lymphocyte Ratio (PNLR), have gained interest in recent years due to their potential utility as non-invasive, cost-effective, and universally available markers[4]. They have been implicated in the pathophysiology of many inflammatory and neoplastic conditions and may serve as prognostic indicators. In particular, these inflammatory markers have shown promising results in predicting outcomes in stone diseases[5]. Furthermore, patients with stone diseases often have variable clinical manifestations, making the prediction of disease severity, progression, and therapeutic outcomes a considerable challenge. Therefore, there is a pressing need to identify reliable and easy-to-measure markers that could predict the severity of stone diseases and guide therapeutic decision-making. To this end, NLR, PLR, and PNLR are attractive candidates. However, the clinical utility of these markers in patients with stone diseases remains to be fully elucidated[4,5].

In light of these gaps in our understanding, the present study was designed to examine the differences in NLR, PLR, and PNLR between two distinct patient groups, further examining their utility as diagnostic markers.

Materials and methods

This study utilized patient disease data from individuals diagnosed with ureteral stone and treated at our medical facility from October, 2020, to January 2023. A total of 150 patients, inclusive of 70 requiring Double J (DJ) catheter placement and 80 who did not, were considered. All patients' records were examined retrospectively. Patients were then separated into two categories: Group 1 (those not require DJ catheter insertion) and Group 2 (those needed DJ catheter insertion). Factors such as patient age, gender, symptoms, diagnosis, hematological parameters, and some indexes (NLR, PLR, and PNLR) were thoroughly assessed.

Every patient included in the study initially presented at the emergency department due to flank pain. Upon arrival, patients underwent a comprehensive examination. All individuals had biochemical and hematological parameter tests, followed by Ultrasonography, X-ray imaging, and computed tomography (CT). Patients diagnosed with ureteral stones were subsequently admitted. Following sufficient hydration, control ultrasonography was performed. Those with residual stones underwent a Ureteroscopy (URS). After the URS, DJ catheters were placed in those patients deemed necessary (patients with edema or severe edema resulting from large stones). Patients who did not require DJ catheter insertion underwent no further procedures.

The study was conducted after obtaining approval from the local ethical committee of Siirt University with no: 69905, date: 03.03.2023.

Descriptive statistics, frequency, and other characteristics for all items were used in the statistical analysis of patient data. Continuous data were represented as mean±standard deviation. Normality of continuous data was assessed using Shapiro-Wilk and Kolmogorov-Smirnov tests. Student's T-test was employed for continuous and normally distributed variables, while non-parametric tests were utilized when data deviated from normal distribution. Chi-square tests were used for categorical variables, and Fisher's exact test was employed where needed. Correlation between data sets was analyzed using Pearson and Spearman correlation tests. ROC analysis was performed for diagnostic performance of the NLR, PLR, and PNLR. Data analyses were performed using SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA).

Results

The study included a total of 150 participants distributed into two groups: Group 1 (n=80) and Group 2 (n=70). The average age of the participants

in Group 1 was 28.45±22.06 years, and for Group 2 it was 32.86±19.82 years (p>0.05). An analysis of age distribution across the two groups was statistically significant (p<0.001). Group 1 had a higher proportion of children (n=41) compared to Group 2 (n=17), while Group 2 had a larger percentage of adults (n=53) compared to Group 1 (n=39). Regarding gender, Group 1 consisted of 49 males and 31 females, whereas Group 2 comprised 44 males and 26 females (p>0.05). The mean stone size was significantly larger in Group 2 (10.35±3.73 mm) than in Group 1 (8.38±2.58 mm) with a statistically significant difference (p<0.001). Stone location (right or left) showed no significant difference between the groups (p>0.05) with 43 instances on the right side in Group 1 compared to 37 in Group 2, and 35 instances on the left side in Group 1 compared to 35 in Group 2. WBC and NEU were significantly higher in Group 2 (WBC: 9.94±3.33, NEU: 7.26±7.05) compared to Group 1 (WBC: 8.31±2.67, NEU: 4.32±2.11) with a p-value of <0.001 for both comparisons. LYM was higher in Group 1 (2.95±1.62) than in Group 2 (2.56±1.93) (p<0.05). However, there were no statistically significant differences between the two groups for MONO (p>0.05) and PLT (p>0.05). While there was no significant difference in urea levels between the groups (p>0.05), the CRE level was significantly higher in Group 2 (0.79±0.72) compared to Group 1 (0.62±0.43) (p < 0.05). NLR, PLR, and PNLR were significantly higher in Group 2 (NLR: 3.96±3.29, PLR: 216.59±394.18, PNLR: 1601.47±4053.49) compared to Group 1 (NLR: 2.14±1.58, PLR: 124.60±51.56, PNLR: 557.31±386.46) with p-values of <0.01 (**Table I**).

For NLR, a cut-off value of >3.14 demonstrated a sensitivity of 41% and a specificity of 83%. The area under the curve (AUC) was 0.683, within a 95% confidence interval (CI) of 0.613 to 0.753, indicating a good predictive ability. The PLR cut-off value was established at >158, providing a sensitivity of 39% and a specificity of 81%. The AUC for PLR was slightly lower than NLR, at 0.595, with a 95% CI of 0.518 to 0.671, suggesting a moderate accuracy. The PNLR cut-off value was determined to be >920. The AUC of PNLR was the highest among the three measures at 0.737, indicating a higher accuracy. The 95% confidence interval for PNLR was between 0.673 and 0.802 (**Table II** and **figure 1**).

There was a positive correlation between stone size and PNLR index (p<0.01, r=0.303) (**Figure 2**).

Table I: Comparison of Characteristics.

	Grup 1 (n=80)	Grup 2 (n=70)	*p*-value
Age (mean±SD, year)	28.45±22.06	32.86±19.82	>0.05
Age group*			**0.001**
Children	41(51%)	17(24%)	
Adult	39(49%)	53(76%)	
Gender*			>0.05
Male	49(61%)	44(63%)	
Female	31(39%)	26(37%)	
Stone size (Mean±SD, mm)	8.38±2.58	10.35±3.73	**<0.001**
Stone side*			>0.05
Right	43(54%)	35(50%)	
Left	37(46%)	35(50%)	
WBC	8.31±2.67	9.94±3.33	**<0.001**
NEU	4.32±2.11	7.26±7.05	**<0.001**
LYM	2.95±1.62	2.56±1.93	**<0.05**
MONO	0.72±0.66	0.83±1.03	>0.05
PLT	321.77±112.46	315.68±110.43	>0.05
UREA	28.22±10.18	30.19±10.79	>0.05
CRE	0.62±0.43	0.79±0.72	**<0.05**
NLR	2.14±1.58	3.96±3.29	**<0.01**
PLR	124.60±51.56	216.59±394.18	**<0.01**
PNLR	557.31±386.46	1601.47±4053.49	**<0.01**

* n(%), Chi-Square test. Others mean±SD, T-test.

Table II: Proposed cut-off values and their diagnostic performans.

	Cut-off value	Sensitivity	Specificity	AUC (95%CI)
NLR	>3.14	41%	83%	0.683(0.613-0.753)
PLR	>158	39%	81%	0.595(0.518-0.671)
PNLR	>920	38%	89%	0.737(0.673-0.802)

Figure 1: ROC Analysis graph for NLR, PLR, and PNLR.

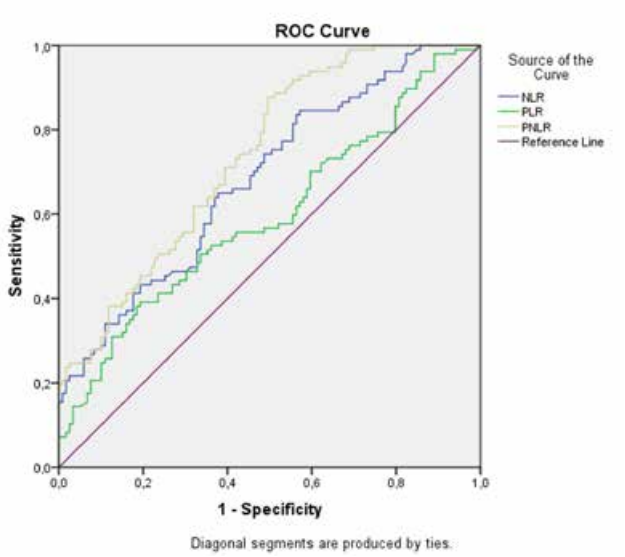
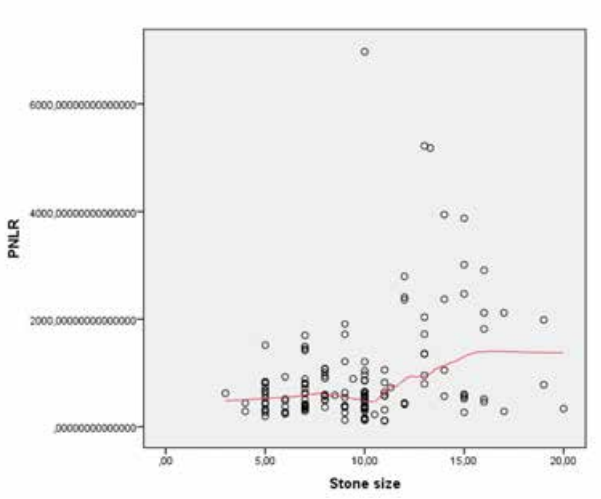


Figure 2: Correlation graph between stone size and PNLR index.



Discussion

The present study aimed to investigate the predictive role of hematological parameters, specifically NLR, PLR, and PNLR, in determining the requirement for DJ catheter placement following URS in patients with ureteral stones. Drawing on retrospective data from our medical facility, we found significant differences in these parameters between patients who required a DJ catheter (Group 2) and those who did not.

Consistent with previous literature, our findings highlight the association between inflammation, as indicated by hematological parameters, and ureteral stone severity[4]. Notably, patients requiring a DJ catheter exhibited higher NLR, PLR, and PNLR indices. This relationship can be attributed to the inflammatory response elicited by ureteral stones, which results in leukocytosis and neutrophilia[5-7].

Moreover, our study suggests that these hematological indices may serve as valuable predictive markers for ureteral stone management. We observed that an NLR cut-off of >3.14 had a good predictive ability with an AUC of 0.683, while a PLR cut-off of >158 and a PNLR cut-off of >920 demonstrated moderate and higher accuracies, respectively. This finding echoes the conclusions of prior research highlighting the prognostic value of these indices in various clinical scenarios, including urolithiasis[6,7].

Furthermore, our study unveiled a significant positive correlation between the stone size and the PNLR index. This finding indicates that as the size of the ureteral stone increases, so does the degree of inflammation, requiring more aggressive interventions such as DJ catheter placement.

Our study also observed a higher prevalence of adults and larger stones in the group requiring a DJ catheter, lending further credence to the literature that suggests stone size, age, and related inflammation influence the necessity of intervention[5,6,8,9] Despite a slight gender disparity across the two groups, this did not translate into a significant difference, aligning with previous studies that have found gender to be a non-determinant factor in ureteral stone intervention[10-12].

Despite these promising findings, it's essential to note that while these indices can be useful in predicting the necessity for DJ catheter placement, they are only part of a more complex picture. The clinical decision must take into account other patient-specific factors and characteristics, like age, symptoms, stone location, and size.

Overall, our findings contribute to the growing body of literature that emphasizes the value of hematological parameters in ureteral stone management. However, further multicenter studies with larger sample sizes are required to validate our results and deepen our understanding of these relationships. The present study is limited by its retrospective nature and the relatively small number of patients. Despite these limitations, our study adds value to clinical practice by enhancing predictive abilities and guiding patient management decisions.

Conclusions

Our study demonstrates the predictive utility of hematological parameters (NLR, PLR, PNLR) in determining the need for DJ catheter placement in ureteral stone patients. These indices, combined with patient-specific factors like age, stone size, and symptoms, can guide personalized management strategies, despite some study limitations. Further research is warranted to confirm our findings.

Conflict of Interest

The authors declare that there is no conflict of interest.

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