



RESEARCH

Diagnostic value of albumin and symptom duration in acute scrotal pain: testicular torsion vs. epididymo-orchitis

Akut skrotal ağrıda albüminin ve semptom süresinin tanısal değeri: testis torsiyonu ve epididimo-orşit

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Abstract

Purpose: The aim of this study was to evaluate inflammatory parameters to differentiate between testicular torsion (TT) and epididymo-orchitis in patients presenting to the emergency department with acute scrotal pain.

Materials and Methods: The study analyzed 241 adult patients who were presented with acute scrotal pain at a tertiary hospital's ED between January 2012 and December 2023.

Results: The cohort comprised 137 patients (56.8%) with epididymo-orchitis and 104 (43.2%) with TT. Median symptom duration was 24 hours (24–48 hours) for epididymo-orchitis cases versus 6 hours (4–10 hours) for torsion cases. Laboratory analysis revealed significantly elevated mean values of monocytes, blood urea nitrogen (BUN), BUN/Albumin ratio (BAR), and Monocyte/Lymphocyte Ratio (MLR) in epididymo-orchitis patients compared to torsion cases, while hemoglobin and albumin levels were significantly lower. As a result of the cox regression analysis revealed that albumin, age and body temperature were independent predictors of the diagnosis. A significant and moderately negative correlation was found between symptom duration and albumin levels. The AUC value of albumin was 0.842 and sensitivity was 80.8% and specificity was 71.5% when the cut-off value was taken as 4.05 mg/dl in the power to predict the presence of testicular torsion.

Conclusion: Albumin level, significantly associated with symptom duration, is a valuable predictor in distinguishing testicular torsion from epididymo-orchitis in patients with acute scrotal pain.

Keywords: Albumin, epididymo-orchitis, inflammation, scrotal pain, testicular torsion.

Özet

Amaç: Bu çalışmanın amacı acil servise akut skrotal ağrı ile başvuran hastalarda testis torsiyonu (TT) ile epididimo-orşit arasındaki ayrımı yapmak amacıyla inflamatuvar parametreleri değerlendirmektir.

Gereç ve Yöntem: Çalışmada, Ocak 2012 ile Aralık 2023 arasında üçüncü basamak bir hastanenin acil servisine akut skrotal ağrıyla gelen 241 yetişkin hasta analiz edildi.

Bulgular: Kohort, epididimo-orşitli 137 hastadan (%56,8) ve TT'li 104 hastadan (%43,2) oluşuyordu. Epididimo-orşit vakalarında medyan semptom süresi 24 saat (24-48 saat) iken torsiyon vakalarında 6 saat (4-10 saat) idi. Laboratuvar analizlerinde epididimo-orşitli hastalarda torsiyon olgularına göre monosit, kan üre azotu (BUN), BUN/Albümin oranı (BAR) ve monosit/lenfosit oranı (MLR) ortalama değerlerinin anlamlı derecede yüksek olduğu, hemoglobin ve albumin düzeylerinin ise anlamlı derecede düşük olduğu saptandı. Cox regresyon analizi sonucunda albumin, yaş ve vücut sıcaklığının tanının bağımsız öngörücüleri olduğu ortaya çıktı. Semptom süresi ile albumin düzeyleri arasında anlamlı ve orta derecede negatif korelasyon bulundu. Albüminin AUC değeri 0,842 idi ve testiküler torsiyon varlığını tahmin etme gücünde kesme değeri 4,05 mg/dl olarak alındığında duyarlılık %80,8 ve özgüllük %71,5 olarak bulundu.

Sonuç: Akut skrotal ağrısı olan hastalarda testis torsiyonunu epididimo-orşitten ayırmada, semptom süresi ile anlamlı ilişki gösteren albumin düzeyi değerli bir belirleyicidir.

Anahtar kelimeler: Albümin, epididimo-orşit, inflamasyon, skrotal ağrı, testis torsiyonu.

INTRODUCTION

Acute scrotal pain in young males often presents a critical diagnostic challenge, with testicular torsion (TT) requiring immediate surgical intervention. Among patients presenting with this symptom, TT and epididymo-orchitis are the primary differential diagnoses. TT is an ischemic condition caused by the rotation of the spermatic cord, which disrupts testicular blood flow, whereas epididymo-orchitis is an infection-induced inflammatory process. Despite their similar initial presentations, TT demands urgent attention due to its time-sensitive surgical management.

TT primarily affects males under 25 years of age, with an incidence of approximately 1 in 4,000 cases¹. The pathophysiological cascade begins with spermatic cord twisting, leading to compromised venous return and subsequent testicular ischemia and necrosis if left untreated². In contrast, epididymo-orchitis develops through bacterial pathogenesis, characterized by a progressive inflammatory response³. Clinical differentiation between these conditions traditionally relies on the Prehn sign and the preservation of the cremasteric reflex in epididymo-orchitis cases. However, while these clinical findings can be helpful, their sensitivity and specificity are limited. Consequently, patients should be evaluated using color Doppler ultrasonography (CDUS) and laboratory findings rather than clinical examination alone. Moreover, severe torsion cases may exhibit overlapping clinical features, complicating accurate diagnosis^{4,5}.

The critical importance of rapid intervention in TT is due to the limited viability of testicular tissue following the onset of ischemia. Research indicates that testicular salvage rates exceed 90% when intervention occurs within six hours of symptom onset, but this rate declines sharply to below 50% after 12 hours². Surgical intervention through detorsion may necessitate orchiectomy in cases of non-viable testicular tissue⁶. Color Doppler ultrasonography (CDUS) is the gold standard diagnostic tool, offering high sensitivity and specificity for distinguishing between TT and epididymo-orchitis by assessing testicular blood flow^{7,8}. Recent research has increasingly focused on inflammatory parameters as additional diagnostic indicators. Specific markers, including leukocyte counts, platelet-lymphocyte ratio (PLR), C-reactive protein (CRP), and blood urea nitrogen-albumin ratio

(BAR), have shown potential utility in assessing disease severity and predicting the need for orchiectomy⁹⁻¹¹.

This study, conducted over a decade in a tertiary hospital in Adana, is a significant investigation examining the prognostic value of inflammatory parameters in distinguishing between testicular torsion and epididymo-orchitis among patients presenting with acute scrotal pain in the emergency department. It is one of the first studies to evaluate the diagnostic value of inflammatory markers in differentiating testicular torsion from epididymo-orchitis in this patient group. Notably, the identification of albumin level as an important predictor in distinguishing between testicular torsion and epididymo-orchitis offers a new perspective to the literature. The primary hypothesis of this study is that albumin levels and symptom duration have significant diagnostic value in differentiating between testicular torsion and epididymo-orchitis in patients with acute scrotal pain. Emphasizing the diagnostic value of simple and accessible parameters such as albumin and symptom duration can contribute to rapid and reliable decision-making in emergency departments.

MATERIALS AND METHODS

Sample

This study analyzed 601 adult patients (≥ 18 years) who were presented with acute scrotal pain at the emergency department of Adana City Training and Research Hospital between January 1, 2012, and December 31, 2023. Patients were excluded for the following reasons: 135 with a diagnosis of varicocele or testicular appendage, 102 with testicular trauma, 22 with testicular malignancy, 58 with a history of prior scrotal surgery, and 32 with immunosuppression or existing liver or kidney disorders. After applying these exclusion criteria, 252 patients remained eligible for analysis. Of these, 11 patients were further excluded due to incomplete or missing data. Ultimately, a total of 241 patients were included in the study, comprising 137 with epididymo-orchitis and 104 with testicular torsion (Figure 1).

The sample size was calculated using G*Power software (version 3.1.9.2; Universität Düsseldorf, Germany) for macOS X. Based on a two-tailed analysis with a 5% Type I error ($\alpha = 0.05$), a 5% Type II error ($\beta = 0.05$, corresponding to a power of 95%),

and an expected medium effect size (Cohen's $d = 0.5$), the minimum required sample size was determined to be 105 patients. However, this study ultimately included 241 patients, exceeding the calculated minimum to enhance the robustness and generalizability of the findings.

Procedure

This study was conducted at Adana City Training and Research Hospital, a high-volume tertiary care center equipped with an advanced hospital electronic record system, ensuring accurate and secure data collection. Patient records were maintained in accordance with institutional protocols, with regular audits to ensure data integrity and accuracy. Following the approval of the ethics committee, patient data were systematically collected by the researchers from the hospital's electronic record system. Data collection included a comprehensive assessment of patient information, such as demographic characteristics, vital signs, and clinical presentations (including the presence of hematuria or anuria and concurrent abdominal pain).

CDUS findings were recorded, detailing arterial and venous blood flow characteristics, echogenicity changes, and the presence of the whirlpool sign. All CDUS evaluations were performed by radiologists with specific expertise in genitourinary imaging. Laboratory parameters included complete blood count (white blood cell count, hemoglobin, platelet count, neutrophils, lymphocytes), inflammatory markers (CRP), and biochemical values (urea, creatinine, albumin). These laboratory analyses were conducted in the hospital's central laboratory, which is accredited and adheres to standard operating procedures to ensure reliable results. Additional clinical data included symptom duration, treatment approach, and hospitalization duration. All collected data were systematically recorded in standardized collection forms, ensuring consistency and completeness.

Statistical analysis

Descriptive statistics were used to present continuous variables as means with standard deviations and categorical variables as frequencies with percentages. Categorical data comparisons were conducted using Chi-square tests. Normality of distribution was assessed using the Kolmogorov-Smirnov test and histogram analysis. Student's *t*-test was applied for normally distributed variables between groups, while

the Mann-Whitney *U* test was used for non-normally distributed variables. The Cox proportional hazards model was employed to evaluate the impact of statistically significant parameters on diagnostic outcomes in patients with epididymo-orchitis and testicular torsion, considering symptom duration. Pearson correlation was applied to normally distributed variables, whereas Spearman correlation was used for non-normally distributed parameters, particularly for inflammatory markers. Receiver operating characteristic (ROC) curve analysis was conducted to assess the predictive performance of the significant parameters identified in the Cox regression analysis. The diagnostic criteria were defined as follows: sensitivity of 100%, zero false positives ($1 - \text{Specificity} = 0$), an area under the curve (AUC) of 1, and a diagnostic value of AUC with $p < 0.05$. The optimal cut-off value was determined using Youden's index, which identifies the point with the highest sensitivity and specificity on the ROC curve. Sensitivity and specificity values, along with 95% confidence intervals, were calculated and presented in a table to evaluate the diagnostic test's accuracy. Statistical analysis was performed using SPSS version 25 software (SPSS Inc, Chicago, Illinois, USA). A *p*-value of < 0.05 was considered statistically significant.

RESULTS

The study evaluated 601 patients who presented to scrotal pain to the ED. After applying exclusion criteria, 241 patients qualified for analysis (Figure 1).

In the study cohort ($n=241$), 56.8% ($n=137$) of patients were diagnosed with epididymo-orchitis, while 43.2% ($n=104$) were diagnosed with testicular torsion (TT). The median age of the overall cohort was 25 years (IQR: 20–41). Patients with TT were significantly younger, with a median age of 19.5 years (IQR: 18–23), compared to those with epididymo-orchitis ($p < 0.001$). Patients with epididymo-orchitis demonstrated significantly higher mean body temperature (37.2°C ; IQR: $37.0\text{--}37.8^{\circ}\text{C}$) and heart rate (89 beats per minute; IQR: 79–98) compared to those with TT ($p < 0.001$ for both parameters). The median duration of symptoms prior to emergency department presentation was significantly longer in the epididymo-orchitis group (24 hours; IQR: 24–48) compared to the TT group (6 hours; IQR: 4–10) ($p < 0.001$) (Table 1).

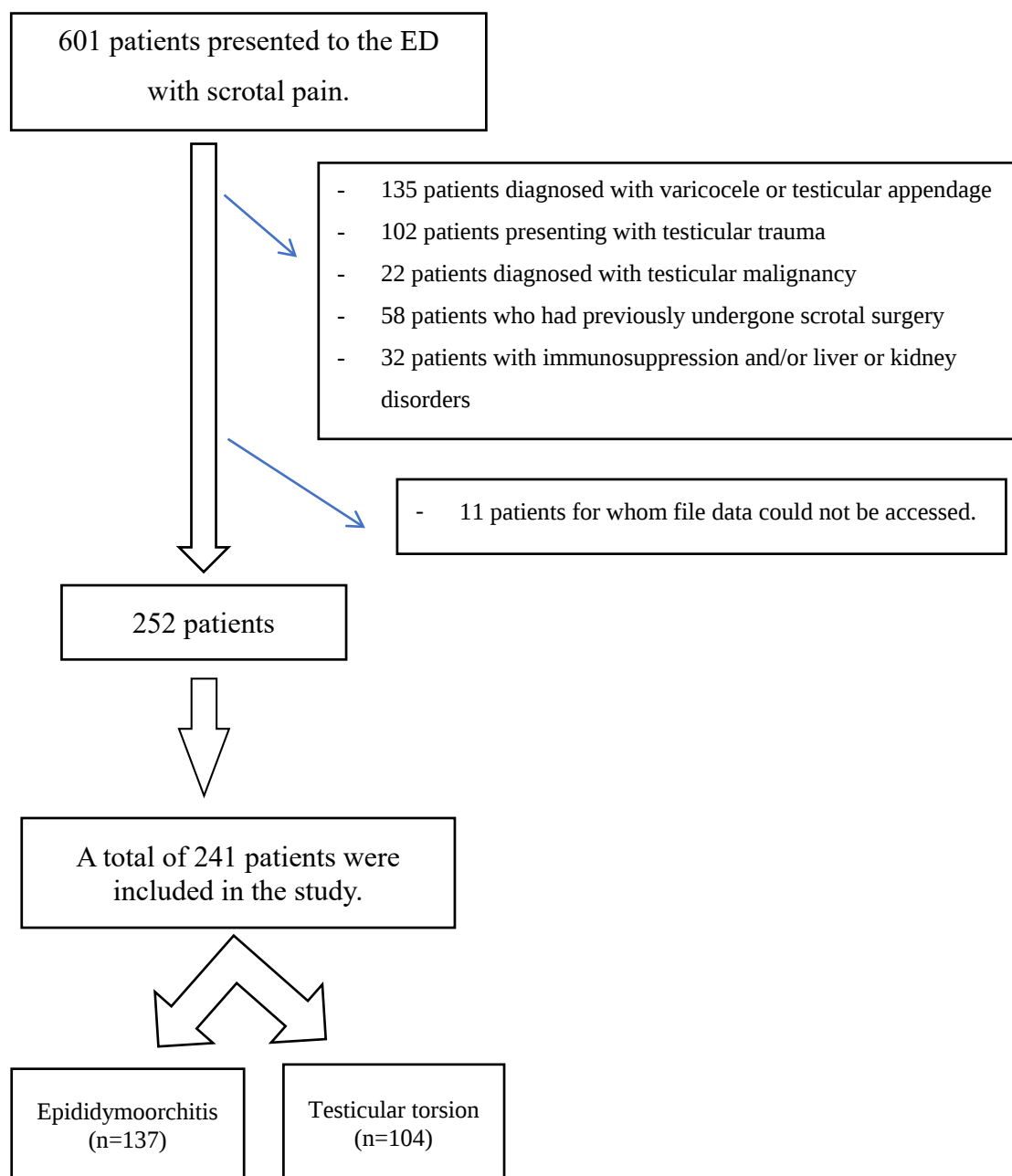


Figure 1. Flowchart of patients included in the study

Emergency department diagnostic ultrasonography identified inflammatory changes in 75.1% of cases, reduced blood flow in 56.8%, testicular torsion in 43.2%, varicocele in 12%, and scrotal hernia in 1.2%.

Inflammatory findings were significantly more common among patients with epididymo-orchitis (75.1%) compared to those with testicular torsion ($p<0.001$). Importantly, there were no instances of

reduced blood flow among patients with testicular torsion ($p<0.001$).

All patients diagnosed with testicular torsion (TT) were hospitalized, along with 11.7% of patients with epididymo-orchitis. The overall median length of hospital stay for all patients was 2 days (IQR: 2–3). Notably, patients with epididymo-orchitis experienced a significantly longer median hospital stay (4.5 days; IQR: 3–11) compared to those with TT (2 days; IQR: 2–3) ($p<0.001$). Among patients with

epididymo-orchitis, 97.8% received conservative medical treatment, while three patients required orchiectomy due to the development of testicular abscess secondary to infection. In the TT group, manual detorsion was performed in 7.1% ($n=17$) of cases. Surgical intervention was required in the remaining patients, with 48.9% ($n=44$) undergoing surgical detorsion, while 51.1% ($n=46$) ultimately required orchiectomy due to non-viable testicular tissue.

Table 1. Demographic features and clinical findings

Features	Total Patients (n=241)	Epididymo- orchitis (n=137)	Testicular Torsion (n=104)	p
Age	25 (20-41)	36 (26-52)	19.5 (18-23)	<0.001
Laterality (%)				0.052
Right	160 (66.4)	98 (71.5)	62 (59.6)	
Left	81 (33.6)	39 (28.5)	42 (40.4)	
Fever (°C)	37 (36.8-37.5)	37.2 (37-37.8)	36.9 (36.5-37)	<0.001
Pulse (beats/min)	85 (75-94)	89 (79-98)	79 (70.3-89)	<0.001
Symptom duration* (h)	18 (6-36)	24 (24-48)	6 (4-10)	<0.001
Laboratory parameters				
WBC (3.6-10.2 $10^3/\mu\text{l}$)	11 (8.5-13.2)	13.5 (8.5-22.6)	10.8 (9.1-12.7)	0.345
Hemoglobin (12.5-16.3 g/dl)	14.6 (13.7-15.6)	10.5 (9.5-14.2)	14.8 (14.2-15.8)	0.025
Platelet (152-348 $10^3/\mu\text{l}$)	244 (206-292.5)	241 (203-293.5)	253.5 (210.5-292)	0.799
Neutrophil (1.7-7.6 $10^3/\mu\text{l}$)	7.6 (5.1-10.3)	10.3 (6.5-19.3)	7.8 (5.3-10.3)	0.624
Lymphocyte (1-3.2 $10^3/\mu\text{l}$)	1.8 (1.3-2.6)	1.3 (0.5-1.4)	1.8 (1.3-2.6)	0.550
Monocyte (0.3-1.1 $10^3/\mu\text{l}$)	0.78±0.34	0.82±0.37	0.72±0.29	0.028
BUN (10-20 mg/dl)	13.5 (11.2-16.8)	14.7 (14-25.9)	13.1 (10.3-15.4)	<0.001
Creatinine (0.67-1.17 mg/dl)	0.78 (0.69-0.89)	0.82 (0.67-1.1)	0.76 (0.69-0.85)	0.311
Albumin (3.5-5.5 g/dl)	4.1 (3.2-4.5)	3.5 (3-4.1)	4.1 (4-4.4)	<0.001
CRP (0-5 mg/L)	29 (12-60)	80.9 (9.1-161.3)	26 (12-50.7)	0.376
BAR	3.6 (2.8-4.7)	4.2 (3.4-5.4)	3 (2.4-3.6)	<0.001
NLR	4.5 (2.2-7.3)	4.7 (2.1-8.7)	4.5 (2.3-7)	0.534
PLR	138.9 (96.2-205.2)	137.2 (97.6-229)	139.3 (91-186.2)	0.378
MLR	0.39 (0.27-0.57)	0.42 (0.26-0.75)	0.36 (0.27-0.49)	0.002

Bold text indicates a statistically significant difference with a p value<0.05.

*: The duration from the onset of the patient's symptoms to presentation at the ED

WBC: White Blood Count; BUN: Blood Urea Nitrogen; CRP: C-Reactive protein; BAR: Blood Urea Nitrogen/Albumin ratio; NLR: Neutrophil/ Lymphocyte ratio; MLR: Monocyte/Lymphocyte ratio

Laboratory analysis revealed significant differences between patients with epididymo-orchitis and those with TT. Patients with epididymo-orchitis demonstrated significantly higher mean values for monocytes ($p=0.028$), blood urea nitrogen (BUN) ($p<0.001$), BUN-to-albumin ratio (BAR) ($p<0.001$), and monocyte-to-lymphocyte ratio (MLR) ($p=0.002$). In contrast, patients with TT exhibited significantly higher hemoglobin ($p=0.025$) and albumin ($p<0.001$) levels. Detailed laboratory parameters are presented in Table 1.

Cox proportional hazards regression analysis was conducted to assess the impact of various clinical and laboratory parameters on the diagnosis of epididymitis and testicular torsion, using symptom duration as the time variable. Specifically, the analysis evaluated the effects of age, heart rate, body temperature, hemoglobin (Hb), blood urea nitrogen (BUN), albumin, monocyte count, BUN-to-albumin ratio (BAR), and monocyte-to-lymphocyte ratio (MLR) on diagnostic outcomes. Symptom duration was defined as the time from symptom onset to the

patient's presentation at the emergency department (Table 2). The analysis revealed that albumin (HR: 2.073, 95% CI: 1.539–2.792, $p < 0.001$), age (HR: 0.984, 95% CI: 0.973–0.994, $p = 0.003$), and body temperature (HR: 0.682, 95% CI: 0.509–0.912, $p = 0.010$) were independent predictors of the diagnosis. Other variables, including monocyte, MLR, Hb, BUN, pulse rate, and BAR, were not statistically

significant predictors ($p > 0.05$) (Table 2). According to the results of the correlation analysis, a significant and moderately negative correlation was found between symptom duration and albumin levels ($r = -0.630$, $p < 0.001$). This indicates that as the symptom duration increases, albumin levels significantly decrease.

Table 2. Cox regression analysis for predicting the effect of parameters on diagnosis depending on the duration of symptoms.

Parameter	B	SE	p.	Exp(B)	95.0% CI	
					Lower	Upper
Albumin	.729	.152	<0.001	2.073	1.539	2.792
Age	-.017	.006	0.003	0.984	0.973	0.994
Fever	-.383	.149	0.010	0.682	0.509	0.912
BAR	.090	.081	0.267	1.094	0.934	1.282
Pulse	.007	.006	0.274	1.007	0.994	1.020
Hb	-.008	.029	0.789	0.992	0.938	1.050
Monocyte	-.015	.225	0.946	0.985	0.634	1.531
BUN	-.022	.032	0.497	0.978	0.919	1.042
MLR	-.046	.170	0.787	0.955	0.684	1.333

The dependent variable was defined as the diagnosis (1 = epididymo-orchitis, 2 = torsion).

The time variable was defined as the duration of symptoms.

Duration of symptoms Duration from the onset of the patient's symptoms to presentation at the ED

Significant variables entered in the independent samples t-test: Age, Fever, Pulse, Hemoglobin, Monocyte, Blood Urea Nitrogen (BUN), Albumin, BUN-albumin ratio (BAR), monocyte/lymphocyte ratio (MLR)

For each variable in the model, the time-dependent impact on diagnosis (hazard ratio, Exp(B)) and its 95% confidence interval (CI) were calculated. Bold text indicates a statistically significant difference with a p value < 0.05 .

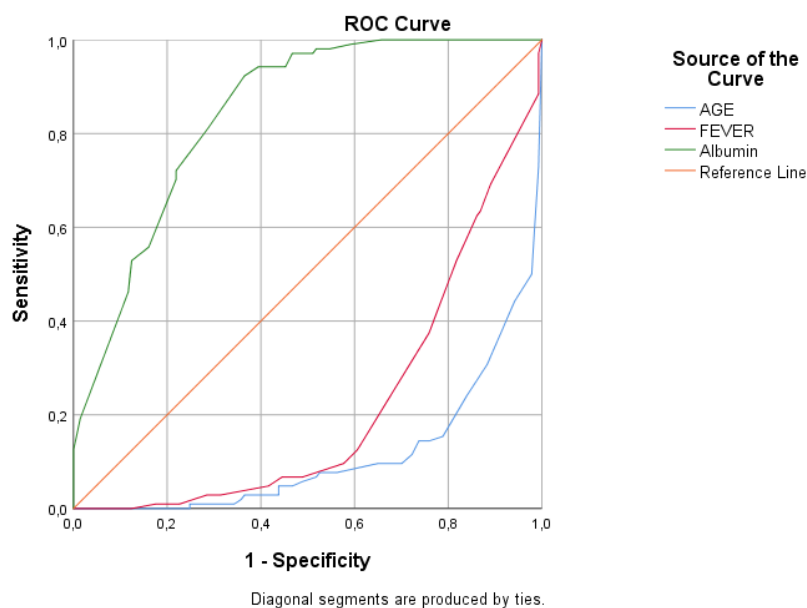
ROC analysis was performed to determine the predictive power of the statistically significant parameters in the cox regression analysis. The ROC curves are summarized in figure 2 and the analysis of these curves is summarized in Table 3. In the comparisons made, it was determined that Age value (AUC: 0.888, 95% CI 0.847-0.929 $p < 0.001$) had the highest predictive power among the predictive values

determined by the area under the curve. The cut-off value for Age was 23.5 years with a sensitivity of 83.9% and a specificity of 76%. The highest AUC value after age value was albumin value (AUC: 0.842, 95% CI 0.794-0.890, $p < 0.001$) and sensitivity was 80.8% and specificity was 71.5% when the cut-off value was taken as 4.05 mg/dl in the power to predict the presence of testicular torsion.

Table 3. Analysis of the ROC curve of the predictive power of parameters for the presence of testicular torsion

	AUC	SE	%95 CI	Cut-off	Sensitivity	Specificity	p
Age	0.888	.021	0,847-0,929	23.5	83.9	76	<0.001
Albumin	0.842	.025	0.794-0.890	4.05	80.8	71.5	<0.001
Fever	0.781	.029	0,724-0,839	37.1	60.6	87.5	<0.001

AUC: Area Under Curve; SE: Standard error; CI: Confidence interval;



1

Figure 2. ROC curve of the predictive power of parameters for the presence of testicular torsion.

DISCUSSION

Acute scrotal pain constitutes a medical emergency, with epididymo-orchitis and testicular torsion (TT) being the most common etiologies. This study aimed to assess the diagnostic value of inflammatory parameters in distinguishing between TT and epididymo-orchitis among patients presenting to the emergency department (ED) with acute scrotal pain. Cox regression analysis was performed to evaluate the impact of various parameters on diagnostic outcomes, accounting for symptom duration. The analysis identified albumin levels and body temperature as independent predictors of diagnosis, demonstrating their potential utility in differentiating between these two conditions.

Testicular torsion (TT) is a critical urological emergency primarily affecting young males, where delayed diagnosis and treatment can result in testicular loss, impaired fertility, or complete infertility. The global incidence of TT is approximately 4 per 100,000 individuals, with significantly higher rates reported in Ireland (16.8 to 26.3 per 100,000)¹². Spermatic cord torsion is a surgical emergency that can lead to testicular infarction within hours, with optimal salvage rates

achieved when surgical intervention occurs within 4–5 hours of symptom onset¹³. Given that clinical presentation may be atypical, imaging plays a crucial role in accurate diagnosis. Color Doppler ultrasonography (CDUS) is recognized as the diagnostic gold standard for TT, providing nearly 100% specificity and high sensitivity^{14–16}. In cases of epididymitis, which often precedes orchitis, characteristic ultrasonographic findings include epididymal enlargement, heterogeneous echotexture, and marked hypervascularity, as opposed to the minimal vascularity observed in a normal epididymis. These changes are frequently accompanied by scrotal skin thickening. Orchitis, whether localized or diffuse, appears as hypoechoic regions on grayscale imaging and hypervascular areas on color or power Doppler ultrasonography¹⁷. The literature consistently emphasizes the importance of ultrasonography in the differential diagnosis of acute scrotal pain in emergency settings¹⁸. Consistent with these findings, this study demonstrated that the presence of inflammatory changes and distinct blood flow patterns serve as significant diagnostic indicators for differentiating epididymitis from testicular torsion. Extensive literature has explored the diagnostic utility of hematological and biochemical parameters in testicular torsion (TT) and other acute

scrotal conditions. Leukocytosis, commonly used as an inflammatory marker, has been reported in several TT studies¹⁹⁻²⁰. Moreover, research has demonstrated that platelet-activating factor antagonists can mitigate ischemic damage, highlighting the role of platelet activation in the pathophysiology of testicular ischemia²¹. Specifically, testicular venous congestion leads to vascular microthrombus formation and activation of the intrinsic coagulation pathway, with platelets playing a pivotal role in microthrombus development. Gunes et al. reported significantly elevated platelet counts in TT cases compared to controls²². However, the present study did not identify platelet count as a significant parameter for differential diagnosis between TT and epididymo-orchitis. In contrast, one study identified monocyte count as the sole significant predictor of testicular viability in TT cases through multivariable analysis²³. In the present study, monocyte count was found to be a significant parameter, while neutrophil and lymphocyte counts demonstrated no diagnostic or therapeutic relevance in TT cases. Monocytes serve as primary inflammatory mediators, acting as both sentinels and effectors of infection²⁴. During inflammatory processes, monocytes rapidly migrate to the site of infection, where they can differentiate into various terminal cell types under the influence of pro-inflammatory or anti-inflammatory mediators and cytokines. This process enhances bactericidal activity and supports the renewal of macrophages and dendritic cells²⁴. Such mechanisms may lead to an elevated monocyte-to-lymphocyte ratio (MLR). Although MLR was observed to be elevated in epididymitis patients in this study, Cox regression analysis did not confirm MLR as an independent diagnostic marker. These findings suggest that while monocyte count may serve as a useful diagnostic indicator, further research is needed to clarify the role of MLR in differentiating acute scrotal conditions.

Blood urea nitrogen (BUN) is a primary byproduct of protein metabolism, predominantly excreted through the kidneys. Elevated BUN levels typically reflect increased protein catabolism or impaired glomerular filtration, making it a critical indicator of renal function and protein metabolic status²⁵. Pain serves as a potent stimulus for the sympathetic nervous system, triggering the activation of the renin-angiotensin-aldosterone system (RAAS). This activation promotes water and sodium reabsorption, leading to passive BUN reabsorption in the renal tubules, while also inducing renal vasoconstriction, thereby reducing BUN excretion²⁶. In the present

study, BUN levels were significantly higher in patients with epididymo-orchitis compared to those with testicular torsion (TT). Although TT is typically characterized by more intense acute pain, the prolonged symptom duration commonly associated with epididymo-orchitis may account for the observed BUN elevation. This extended pain exposure in epididymo-orchitis may lead to sustained sympathetic activation and subsequent alterations in renal function, ultimately contributing to elevated BUN levels.

The pathophysiology of testicular torsion (TT) is characterized by oxidative damage, with testicular injury resulting from both ischemic and reperfusion processes. Research has demonstrated that free radical generation during reperfusion is a key contributor to tissue injury in TT²⁷⁻²⁸. In contrast, epididymo-orchitis is primarily an inflammatory condition, marked by the activation of acute-phase responses. These responses are characterized by decreased levels of negative acute-phase proteins (e.g., prealbumin, albumin, transferrin) and elevated levels of positive acute-phase proteins (e.g., C-reactive protein [CRP], haptoglobin, fibrinogen)²⁹. Acute-phase proteins perform multiple physiological roles, including the direct neutralization of inflammatory agents, limitation of local tissue damage, and facilitation of tissue repair and regeneration^{29,30}. Albumin, a fundamental clinical laboratory parameter, plays a critical role in various physiological processes³¹. During inflammation, increased microvascular permeability alters the distribution of albumin between the intravascular and extravascular compartments, resulting in decreased serum albumin levels, particularly among critically ill patients³². In the present study, serum albumin levels classified as a negative acute-phase reactant were significantly lower in patients with epididymo-orchitis compared to those with TT. This difference can be attributed to the enhanced microvascular permeability associated with the inflammatory cascade in epididymo-orchitis, which facilitates albumin extravasation and reduces serum albumin concentrations. The prolonged inflammatory burden characteristic of epididymo-orchitis may lead to sustained alterations in vascular permeability and protein metabolism, further contributing to reduced serum albumin levels. These findings underscore the potential clinical utility of monitoring albumin levels in patients with prolonged epididymo-orchitis, providing insights into the systemic impact of inflammation and guiding therapeutic strategies and

risk stratification. Moreover, this study also observed an increase in the BUN-to-albumin ratio (BAR) among epididymo-orchitis cases due to the concurrent decrease in albumin and elevation of BUN levels. Although BAR did not emerge as a statistically significant parameter in the Cox regression analysis, it may still hold diagnostic potential, given its established predictive value for mortality in various conditions, including sepsis, pneumonia, chronic obstructive pulmonary disease, acute coronary syndrome, and heart failure³³⁻³⁸. Notably, this study is the first to investigate the diagnostic value of BAR in the differential diagnosis of acute scrotal pain. The findings suggest that BAR may offer significant diagnostic value in distinguishing epididymo-orchitis from TT in emergency department presentations of scrotal pain. These results emphasize the importance of inflammatory parameters in differentiating these two conditions and highlight the need for larger, prospective studies to validate and expand upon these findings.

This study's retrospective observational case series design is inherently associated with limitations related to the completeness and accuracy of clinical data documentation. The single-center nature of data collection further restricts the generalizability of the findings, emphasizing the need for multicenter studies to validate the current results. Additionally, the sample size may have been insufficient to achieve adequate statistical power, particularly for subgroup comparative analyses, limiting the robustness of the findings in these specific contexts. Another critical limitation is the assessment of serum albumin levels exclusively at the time of admission, without subsequent follow-up or discharge measurements. This approach precludes an evaluation of dynamic changes in albumin levels and their potential impact on long-term prognosis. Future studies that include serial albumin measurements could provide a more comprehensive understanding of the temporal role of albumin in disease progression and patient outcomes. Future research should prioritize prospective, large-scale investigations that incorporate data from multiple centers. Such studies would enhance the external validity of findings and provide a more definitive understanding of the prognostic value of inflammatory markers in the differential diagnosis of acute scrotal pain.

Testicular survival following torsion is strongly dependent on minimizing the time between clinical

presentation and therapeutic intervention. In this study, symptom duration and serum albumin levels were identified as the most significant predictors of testicular torsion. Serum albumin assessment emerged as a simple, rapid, and highly effective tool in the evaluation of acute scrotal pain. These findings suggest that serum albumin may serve as a valuable aid in emergency decision-making.

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