

ORIGINAL RESEARCH

Early leukocyte-based inflammatory markers and ischemia duration are associated with the need for surgical shunting in acute ischemic priapism: an exploratory retrospective cohort study

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(Caner Özer)**Abstract**

Background: Acute ischemic priapism is a time-dependent urological emergency in which failure of stepwise conservative treatment requires emergency surgical shunting, and prolonged cavernosal ischemia may cause permanent erectile dysfunction. The parameters available at presentation that identify which patients will fail conservative therapy and require shunting are poorly defined, and leukocyte-based inflammatory markers have not previously been examined in this emergency. We therefore assessed whether these parameters are associated with the need for surgical shunting, with post-priapism erectile dysfunction as a secondary outcome. **Methods:** Among 23 adults with acute ischemic priapism, 15 were managed conservatively and 8 required surgical shunting; admission leukocyte-based inflammatory markers and ischemia duration were examined for their association with the need for surgical shunting. **Results:** Patients who required shunting had a markedly longer ischemia duration (median 48 versus 7.5 hours) and a higher admission white blood cell count (median 13.3 versus $10.0 \times 10^9/L$), with higher neutrophil and monocyte counts, whereas composite inflammatory indices such as the neutrophil-to-lymphocyte ratio and the systemic immune-inflammation index did not differ. The admission white blood cell count discriminated the need for surgical shunting with an area under the curve of 0.84, comparable to ischemia duration (0.82); a threshold of approximately $13 \times 10^9/L$ gave 75% sensitivity and 87% specificity, while the composite indices were non-discriminatory. The white blood cell count correlated only moderately with ischemia duration, indicating information not fully explained by elapsed time. Post-priapism erectile dysfunction, a secondary outcome, was related only to older age. **Conclusions:** In acute ischemic priapism, a longer ischemia duration and a higher early leukocyte count at presentation are associated with the need for emergency surgical shunting, whereas composite inflammatory indices are not; these simple, immediately available parameters may support early risk stratification and merit validation in larger, multicentre studies.

Keywords

Priapism; Leukocytes; Inflammation; Ischemia; Erectile dysfunction; Emergencies; Surgery

Marcadores inflamatorios tempranos basados en leucocitos y duración de la isquemia se asocian con la necesidad de derivación quirúrgica en el priapismo isquémico agudo: un estudio de cohorte retrospectivo exploratorio

Resumen

Antecedentes: El priapismo isquémico agudo es una urgencia urológica dependiente del tiempo en la que el fracaso del tratamiento conservador escalonado obliga a realizar una derivación quirúrgica urgente, y la isquemia cavernosa prolongada puede causar disfunción eréctil permanente. Los parámetros disponibles en el momento de la presentación que permiten identificar qué pacientes fracasarán con el tratamiento conservador y requerirán derivación están poco definidos, y los marcadores inflamatorios basados en leucocitos no se habían examinado previamente en esta urgencia. **Métodos:** Entre 23 adultos con priapismo isquémico agudo, 15 fueron tratados de forma conservadora y 8 requirieron derivación quirúrgica; se examinaron los marcadores inflamatorios basados en leucocitos al ingreso y la duración de la isquemia en relación con la necesidad de derivación quirúrgica. **Resultados:** Los pacientes que requirieron derivación presentaron una duración de la isquemia notablemente mayor (mediana de 48 frente a 7.5 horas) y un recuento de leucocitos al ingreso más elevado (mediana de 13.3 frente a $10.0 \times 10^9/L$), con recuentos de neutrófilos y monocitos más altos, mientras que los índices inflamatorios compuestos, como el índice neutrófilo-linfocito y el índice de inmunoinflamación sistémica, no difirieron. El recuento de leucocitos al ingreso discriminó la necesidad de derivación quirúrgica con un área bajo la curva de 0.84, comparable a la duración de la isquemia (0.82); un umbral de aproximadamente $13 \times 10^9/L$ proporcionó una sensibilidad del 75% y una especificidad del 87%, mientras que los índices compuestos no fueron discriminativos. El recuento de leucocitos se correlacionó solo moderadamente con la duración de la isquemia, lo que indica información no explicada por completo por el tiempo transcurrido. La disfunción eréctil pospriapismo, un resultado secundario, se relacionó únicamente con la edad avanzada. **Conclusiones:** En el priapismo isquémico agudo, una mayor duración de la isquemia y un recuento leucocitario temprano más alto en la presentación identifican a los pacientes que fracasan con el tratamiento conservador y requieren derivación quirúrgica urgente, mientras que los índices inflamatorios compuestos no lo hacen; estos parámetros sencillos e inmediatamente disponibles pueden apoyar la estratificación temprana del riesgo y merecen validación en estudios multicéntricos más amplios.

Palabras Clave

Priapismo; Leucocitos; Inflamación; Isquemia; Disfunción eréctil; Urgencias; Cirugía

1. Introduction

Acute ischemic priapism is a urological emergency characterised by a prolonged, painful penile erection resulting from impaired venous outflow and progressive cavernosal ischemia [1–3]. It is managed as a time-dependent emergency: first-line treatment follows a stepwise conservative algorithm of corporal aspiration, irrigation and intracavernosal sympathomimetic agents, and when these fail, emergency surgical shunting is performed [4, 5]. If detumescence is not achieved promptly, sustained ischemia leads to cavernosal smooth-muscle necrosis, fibrosis and permanent erectile dysfunction (ED), with largely irreversible injury accruing within approximately 24–36 h of onset [1–4].

Ischemia duration is the single most important determinant of cavernosal injury and outcome [3, 6, 7]. From an emergency-surgical standpoint, however, the more immediate question is which patients, at presentation, will fail conservative therapy and require operative shunting. In the largest single-institution series addressing this question, priapism duration and prior priapism were the only independent predictors of surgical shunting, and a 24-h threshold best discriminated the need for surgery [6]. Contemporary population-level data confirm that, although most patients are managed medically, a minority escalate to surgery and develop de novo ED [7, 8]. The need for shunting reflects a greater ischemic burden and

carries higher procedural morbidity [9, 10], yet the parameters that identify this escalation at admission remain incompletely defined.

Systemic leukocyte-based inflammatory parameters—the white blood cell (WBC) and differential counts and derived indices such as the neutrophil-to-lymphocyte ratio (NLR) and the systemic immune-inflammation index (SII)—are inexpensive, immediately available markers of disease severity in emergency and acute-surgical settings. In sexual medicine they have been linked to ED, but almost exclusively in chronic, vasculogenic settings [11, 12]; their behaviour in acute ischemic priapism has not been reported. Acute ischemia is accompanied by stress-induced leukocytosis that may track the severity of cavernosal injury and the likelihood of conservative-treatment failure rather than long-term erectile function [2, 3]. Mechanistically, acute cavernosal ischemia triggers sterile inflammation: hypoxia and cell injury release damage-associated molecular patterns that activate resident cells and rapidly mobilise neutrophils and monocytes into the circulation, producing an early, measurable leukocytosis whose magnitude may parallel the extent of ischemic injury [13, 14]. We therefore aimed to identify factors associated with escalation from conservative management to emergency surgical shunting, with particular attention to ischemia duration and early leukocyte-based inflammatory parameters; post-priapism ED and the timing of presentation were

secondary objectives.

2. Materials and methods

2.1 Study design and diagnosis

This single-centre retrospective cohort study included adult patients diagnosed with acute ischemic priapism. Ischemic priapism was diagnosed from history and examination and confirmed, where required, by corporal blood gas (partial pressure of oxygen (pO_2) <30 mmHg; partial pressure of carbon dioxide (pCO_2) >60 mmHg; $pH <7.25$) and/or colour-Doppler ultrasonography showing absent or minimal cavernosal arterial inflow, in accordance with American Urological Association/Sexual Medicine Society of North America (AUA/SMSNA) criteria [4]. Reporting follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for observational studies.

2.2 Patients and data collection

Patients were identified from institutional electronic medical records. Inclusion criteria were age ≥ 18 years, a confirmed diagnosis of ischemic priapism and complete baseline clinical and laboratory data at presentation. Patients with non-ischemic priapism or insufficient documentation were excluded; one patient younger than 18 years was excluded to maintain an adult cohort. Collected variables comprised age, body mass index (BMI), comorbidities, haematological disorders and aetiology; temporal variables (symptom (ischemia) duration, onset-to-presentation and onset-to-first-intervention intervals, in hours); presentation characteristics (initial hospital, referral status, office hours versus out-of-hours); and admission WBC, neutrophil, lymphocyte, monocyte and platelet counts, red-cell distribution width and mean platelet volume. The NLR, platelet-to-lymphocyte ratio (PLR), monocyte-to-lymphocyte ratio (MLR) and SII were calculated using standard formulae. Data were collected from January 2014 to December 2025.

2.3 Treatment strategy and outcomes

Conservative management followed a standardized, guideline-based stepwise protocol (corporal aspiration, saline irrigation and intracavernosal phenylephrine) in accordance with the European Association of Urology guidelines on priapism [15]. Patients were classified as non-shunt (managed conservatively) or shunt (requiring emergency surgical shunting after conservative failure). The primary outcome was the need for surgical shunting. Post-priapism ED—from documented clinical evaluation, defined as the inability to achieve or maintain penile rigidity sufficient for vaginal penetration—was a secondary outcome; a validated instrument such as the five-item International Index of Erectile Function was not uniformly available, which is acknowledged as a limitation.

2.4 Statistical analysis

Data analyses used IBM SPSS Statistics (version 22, IBM Corp., Armonk, NY, USA) and Python 3 (SciPy and scikit-learn). Normality was assessed with the Shapiro-Wilk test; as

most continuous variables were non-normally distributed, data are presented as median (interquartile range, IQR) and compared with the Mann-Whitney U test, with the rank-biserial correlation coefficient (r) as an effect-size measure. Categorical variables are presented as number (percentage) and compared with Fisher's exact test. The association between admission WBC and ischemia duration was examined with the Spearman rank correlation. The discrimination of WBC and ischemia duration for the need for shunting was assessed by receiver-operating-characteristic (ROC) analysis, reporting the area under the curve (AUC) with a bootstrap 95% confidence interval (CI; 5000 resamples) and the Youden-optimal threshold with sensitivity and specificity. A two-sided $p < 0.05$ was considered statistically significant. Given the exploratory design and limited sample, findings are hypothesis-generating and were not corrected for multiple comparisons. No formal a priori sample-size calculation was performed; acute ischemic priapism is an uncommon emergency, and all consecutive adult patients with a confirmed diagnosis and complete data during the study period were included, so the analyses are exploratory and hypothesis-generating.

3. Results

3.1 Factors associated with the need for surgical shunting

Twenty-three patients were analysed: 15 managed conservatively (non-shunt) and 8 requiring emergency surgical shunting. The shunt group had a markedly longer ischemia duration than the non-shunt group (48.0 (31.5–69.0) versus 7.5 (6.0–20.5) h; $p = 0.028$; $r = 0.64$). Admission leukocyte-based counts were higher in patients requiring shunting: WBC (13.32 versus $9.97 \times 10^9/L$; $p = 0.007$; $r = 0.68$), neutrophil (8.95 versus $7.10 \times 10^9/L$; $p = 0.036$; $r = 0.55$) and monocyte (1.05 versus $0.80 \times 10^9/L$; $p = 0.048$; $r = 0.52$) counts. The composite indices (NLR, PLR, MLR, SII) did not differ between groups. Out-of-hours presentation was more frequent among non-shunt patients (12/15, 80%) than shunt patients (2/8, 25%; Fisher $p = 0.023$), consistent with longer ischemia times and a delayed-referral pattern in the shunt group (Table 1).

Admission WBC correlated only moderately, and non-significantly, with ischemia duration (Spearman $r = 0.43$, $p = 0.060$), indicating that the early leukocyte signal was not simply a surrogate for elapsed ischemia time. In exploratory ROC analysis, admission WBC discriminated the need for surgical shunting with an AUC of 0.84 (95% CI 0.63–0.99); a Youden-optimal threshold of $13.1 \times 10^9/L$ gave 75% sensitivity and 87% specificity, and a pragmatic threshold of $12 \times 10^9/L$ gave 75% sensitivity and 80% specificity. Ischemia duration showed comparable discrimination (AUC 0.82, 95% CI 0.61–1.00). In contrast, the composite indices were essentially non-discriminatory (NLR AUC 0.54; SII AUC 0.58), while neutrophil and monocyte counts were intermediate (AUC 0.78 and 0.76). When both criteria were combined (WBC $\geq 12 \times 10^9/L$ and ischemia duration ≥ 24 h), specificity for the need for shunting reached 93% with a positive predictive value of 80% (Fig. 1). Given the small sample, these areas under the curve carry wide confidence

TABLE 1. Characteristics by the need for surgical shunting.

Variable	Non-shunt (n = 15)	Shunt (n = 8)	<i>p</i>	<i>r</i>
Age (yr)	49.0 (45.5–65.5)	54.5 (47.8–66.0)	0.674	0.12
BMI (kg/m ²)	26.1 (24.3–27.3)	25.5 (24.9–26.1)	0.498	–0.18
Ischemia duration (h)	7.5 (6.0–20.5)	48.0 (31.5–69.0)	0.028	0.64
WBC ($\times 10^9/L$)	9.97 (8.4–11.3)	13.32 (12.7–16.0)	0.007	0.68
Neutrophil ($\times 10^9/L$)	7.10 (4.7–8.6)	8.95 (7.7–12.7)	0.036	0.55
Monocyte ($\times 10^9/L$)	0.80 (0.6–1.0)	1.05 (0.9–1.2)	0.048	0.52
Lymphocyte ($\times 10^9/L$)	1.72 (1.4–2.1)	2.25 (1.7–2.9)	0.175	0.36
NLR	3.73 (2.4–5.6)	4.32 (2.8–7.1)	0.796	0.07
PLR	147.0 (123.0–235.1)	110.9 (82.3–207.1)	0.169	–0.37
MLR	0.37 (0.34–0.52)	0.38 (0.33–0.52)	0.825	0.07
SII	1077.5 (628–1692)	1172.3 (722–1961)	0.548	0.17
Out-of-hours presentation, n (%)	12 (80)	2 (25)	0.023 ^a	—

Data are presented as median (IQR) or n (%). ^aFisher's exact test; all other comparisons by Mann-Whitney U test (effect size, rank-biserial *r*). BMI, body mass index; IQR, interquartile range; MLR, monocyte-to-lymphocyte ratio; NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; SII, systemic immune-inflammation index; WBC, white blood cell.

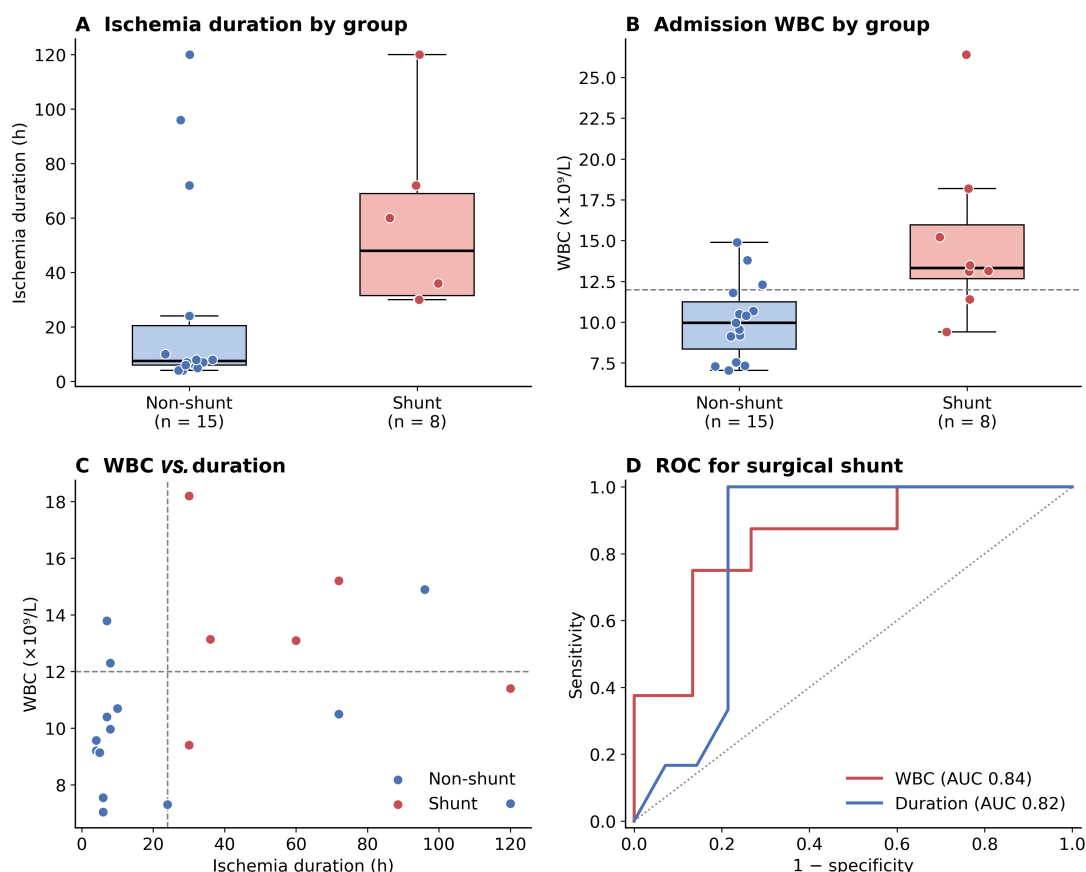


FIGURE 1. Early predictors of the need for surgical shunting in acute ischemic priapism. (A) Ischemia duration and (B) admission white blood cell (WBC) count in patients managed conservatively (non-shunt, n = 15) versus those requiring surgical shunting (n = 8); boxes show median and interquartile range and points are individual patients (dashed line in B at $12 \times 10^9/L$). (C) Scatter of WBC versus ischemia duration by group (dashed lines at 24 h and $12 \times 10^9/L$). (D) Exploratory receiver-operating-characteristic curves for WBC and ischemia duration predicting the need for surgical shunting. AUC, area under the curve; ROC, receiver-operating-characteristic; WBC, white blood cell.

intervals, and the reported thresholds should be regarded only as preliminary, exploratory observations for hypothesis generation rather than as clinical decision criteria.

3.2 Secondary outcome: post-priapism erectile dysfunction

ED was identified in 15 patients and absent in 8. Patients with ED were older than those without (61.0 (50.0–68.0) versus 46.5 (37.3–48.3) years; $p = 0.022$; $r = -0.60$). No differences were observed between ED groups in BMI, symptom duration, time to presentation, time to first intervention or any inflammatory parameter (Table 2).

4. Discussion

In this emergency-surgical cohort of acute ischemic priapism, two parameters available at presentation—longer ischemia duration and a higher early leukocyte count (WBC, neutrophil and monocyte)—were associated with the need for surgical shunting. The composite inflammatory indices did not discriminate between groups, and post-priapism ED was related chiefly to older age. To our knowledge, this is the first study to examine leukocyte-based inflammatory parameters in acute ischemic priapism and to relate them specifically to the need for emergency surgical intervention.

The discrimination of ischemia duration in our cohort (AUC 0.82) closely matches the 0.83 reported by Zhao *et al.* [6] in 169 patients, and our shunt versus non-shunt durations (48 versus 7.5 h) mirror their 36 versus 10 h, reproducing the established temporal signal in an independent cohort. We extend it by showing that a single admission WBC carries comparable, biologically distinct predictive information (AUC 0.84): because WBC correlated only moderately with duration ($r = 0.43$), the leukocyte signal is not merely a proxy for elapsed time. Neutrophils and monocytes are central effectors of ischemia-reperfusion injury, and the magnitude of leukocyte activation tracks the severity of ischemic tissue damage [13, 14]; an elevated early count therefore plausibly indexes the cavernosal ischemic burden that determines whether conservative therapy succeeds. The composite ratios likely dilute this

signal by normalising the very neutrophil and monocyte counts that carry the prognostic information, which would explain their near-chance discrimination despite being informative for chronic vasculogenic ED [11, 12].

An important caveat is that we could not adjust for potential confounders—age, priapism aetiology, comorbidity and inter-hospital referral delay—because the small sample and the low number of events (eight surgical shunts) preclude reliable multivariable modelling. We therefore cannot establish whether the admission leukocyte count is an independent predictor of surgical escalation or, rather, an epiphenomenon of prolonged ischemia; the only evidence bearing on this question is the moderate, non-significant correlation between admission white blood cell count and ischemia duration ($r = 0.43$), which suggests the leukocyte signal is not fully explained by elapsed time but does not by itself establish independence. The predictive interpretation of the leukocyte count should therefore be regarded as hypothesis-generating and requires confirmation in adequately powered, adjusted analyses.

The failure of the composite indices (neutrophil-to-lymphocyte, platelet-to-lymphocyte and monocyte-to-lymphocyte ratios and the systemic immune-inflammation index) to discriminate between groups is mechanistically plausible. These ratios were derived and validated largely in chronic, low-grade vasculogenic conditions [11, 12], where they capture a relative shift between neutrophils or platelets and lymphocytes. In acute ischemia, by contrast, the informative signal is an absolute, early rise in innate effector cells—neutrophils and monocytes [13, 14]; expressing these counts as a ratio to a concurrently and variably changing lymphocyte count normalises away the very signal that carries the prognostic information and adds noise, which may explain their near-chance discrimination in our cohort.

The timing of presentation related to treatment in the opposite direction to naive expectation: out-of-hours presentation was more common among conservatively managed patients, whereas patients requiring shunting presented predominantly in office hours. This most plausibly reflects that patients escalating to surgery were largely delayed inter-hospital referrals with prolonged ischemia who arrived during the working day,

TABLE 2. Characteristics by erectile dysfunction status.

Variable	ED present (n = 15)	ED absent (n = 8)	<i>p</i>	<i>r</i>
Age (yr)	61.0 (50.0–68.0)	46.5 (37.3–48.3)	0.022	–0.60
BMI (kg/m ²)	25.9 (24.7–26.8)	25.7 (24.6–26.8)	0.974	–0.02
Ischemia duration (h)	17.0 (7.0–69.0)	19.0 (5.8–30.0)	0.679	–0.13
Symptom-to-hospital (h)	10.0 (7.0–72.0)	6.5 (5.0–24.5)	0.378	–0.27
Symptom-to-intervention (h)	10.0 (6.0–73.0)	6.5 (5.0–24.5)	0.598	–0.17
NLR	4.35 (2.9–6.5)	2.44 (2.3–5.1)	0.186	–0.35
SII	1088 (650–2015)	894 (638–1599)	0.636	–0.13
WBC ($\times 10^9/L$)	11.40 (10.0–13.5)	9.69 (9.2–12.2)	0.466	–0.20

Data are presented as median (IQR); comparisons by Mann-Whitney *U* test (effect size, rank-biserial *r*). BMI, body mass index; ED, erectile dysfunction; IQR, interquartile range; NLR, neutrophil-to-lymphocyte ratio; SII, systemic immune-inflammation index; WBC, white blood cell.

whereas early presenters attending out-of-hours responded to conservative measures—reinforcing that prolonged ischemia and delayed definitive management, not the clock time of arrival, drive escalation [6, 9]. Because several patients who required shunting were late inter-hospital transfers, this referral pattern may inflate the observed association between ischemia duration, leukocytosis and surgical escalation, and our estimates should be interpreted with this bias in mind.

Post-priapism ED, our secondary outcome, was associated only with older age, concordant with contemporary data in which age and comorbidity predict *de novo* ED [8] and with the dominant effect of ischemia duration on ED in a recent 186-patient series [7]; erectile dysfunction is a well-documented sequela of treated priapism in single-institution experience [16], and our inability to reproduce the duration-ED association almost certainly reflects limited power rather than a true absence of effect. Consistent with this, a comparable retrospective surgical series identified delayed treatment, cavernosal fibrosis and the need for a distal shunt—rather than admission inflammatory markers—as the main determinants of poorer post-treatment erectile function [17]. Taken together, early leukocyte-based inflammation appears to mark acute ischemic burden and the need for emergency surgical escalation rather than long-term erectile outcome—which is why we frame escalation, not ED, as the primary message. Clinically, two parameters available within minutes at presentation—time since onset and the admission leukocyte count—may help flag the patient likely to fail conservative measures and require shunting, complementing, not replacing, clinical judgement and the stepwise algorithm.

The retrospective, single-centre design and small sample ($n = 23$; 8 shunt and 8 ED-absent patients) limit power, preclude multivariable modelling, and make all associations exploratory, unadjusted for multiple comparisons, and subject to both type I and type II error; the ROC thresholds are illustrative for this cohort rather than validated cut-offs. Priapism is uncommon and small single-centre series remain the norm [7, 10], but our estimates are imprecise and require confirmation. Selection and referral bias are likely, given that several shunt patients were delayed transfers, and the heterogeneous aetiology may limit generalisability [6]. ED was ascertained from clinical documentation rather than a validated instrument, the follow-up interval was not standardised, the temporal variables were collinear, and corporal blood gas/Doppler was not available for every patient. Larger, prospective, multicentre studies with standardised outcomes are needed to confirm whether early leukocyte-based parameters can stratify the risk of surgical escalation and to define clinically useful thresholds.

5. Conclusions

In this exploratory, single-centre retrospective cohort of acute ischemic priapism, a longer ischemia duration and a higher early leukocyte count at presentation were associated with the need for emergency surgical shunting, whereas the composite inflammatory indices (NLR, PLR, MLR and SII) did not discriminate between groups. To our knowledge, this is the first study to examine leukocyte-based inflammatory parameters in acute ischemic priapism and to relate them specifically to

the need for emergency surgical intervention; it adds to a literature centred on ischemia duration by showing that a single admission leukocyte count carries predictive information that is not merely a proxy for elapsed ischemia time. Because both the time since onset and the admission leukocyte count are available within minutes at presentation, they may help flag the patient likely to fail stepwise conservative therapy and require shunting—complementing, not replacing, clinical judgement and the guideline-based stepwise algorithm.

These findings are, however, hypothesis-generating. The retrospective, single-centre design and the small number of surgical events preclude multivariable adjustment and cannot establish whether the admission leukocyte count is an independent predictor or, rather, an epiphenomenon of prolonged ischemia, and the thresholds observed here are preliminary rather than validated cut-offs. Larger, prospective, multicentre studies with standardised outcomes are needed to confirm whether early leukocyte-based parameters can stratify the risk of surgical escalation and to define clinically useful thresholds.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

CÖ—Conceptualization; methodology; formal analysis; data curation; visualization; writing—original draft preparation; project administration. GC—Conceptualization; investigation; supervision. BB, HCK and AÇ—investigation. All authors contributed to writing—review and editing and have read and agreed to the published version of the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Ethics Committee of Trakya University Faculty of Medicine, Edirne, Türkiye (approval number 2026/49). Given the retrospective design and the use of anonymised, routinely collected clinical data, informed consent was not obtained, in accordance with paragraph 32 of the Declaration of Helsinki.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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