

Predictors of Functional Outcomes After Penile Fracture Repair: The Role of Education Level and Tunica Albuginea Tear Size

Penil Fraktür Onarımı Sonrası Fonksiyonel Sonuçların Belirleyicileri: Eğitim Seviyesi ve Tunica Albuginea Yırtık Boyutunun Rolü

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Abstract

To evaluate the impact of tunica albuginea tear size and time to hospital presentation on postoperative erectile dysfunction (ED) after penile fracture repair and determine the optimal tear size threshold for predicting ED. This retrospective study included 20 patients who underwent immediate surgical repair between April 2023 and March 2025. Postoperative ED was defined as an International Index of Erectile Function-5 (IIEF-5) score ≤ 21 . Group comparisons were performed using Fisher's exact and Mann-Whitney U tests. Univariate logistic regression and receiver operating characteristic (ROC) analyses were used to identify factors associated with ED and determine the optimal tear size cut-off. Postoperative ED developed in 10 patients (50.0%). Patients with ED had a longer time to hospital presentation than those without ED (median, 6.0 vs. 3.5 hours; $p=0.005$). A tunical tear size >1.8 cm was more frequent in patients with ED (70.0% vs. 10.0%; $p=0.020$). Each additional hour before presentation increased the odds of ED approximately 2.3-fold (OR=2.336, 95% CI: 1.049–5.202; $p=0.038$), while tear size >1.8 cm was associated with 21-fold higher odds (OR=21.00, 95% CI: 1.77–248.10; $p=0.016$). ROC analysis showed that tear size >1.8 cm predicted ED with an AUC of 0.765 (95% CI: 0.528–1.000; $p=0.028$), 70.0% sensitivity, and 90.0% specificity. Delayed presentation and larger tunical tear size were associated with postoperative ED. A tear size >1.8 cm may be useful for postoperative risk stratification.

Keywords: Complication, Educational level, Erectile dysfunction, Penile fracture.

Özet

Penil fraktürün cerrahi onarımı sonrasında tunika albuginea yırtık boyutu ve hastaneye başvuru süresinin postoperatif erektil disfonksiyon (ED) üzerindeki etkisini değerlendirmek ve ED'yi öngörmeye optimal yırtık boyutu eşik değerini belirlemek amaçlandı. Bu retrospektif çalışmaya Nisan 2023–Mart 2025 tarihleri arasında penil fraktür nedeniyle acil cerrahi onarım uygulanan 20 hasta dahil edildi. Postoperatif ED, Uluslararası Eretil Fonksiyon İndeksi-5 (IIEF-5) skoru ≤ 21 olarak tanımlandı. Gruplar Fisher'in kesin testi ve Mann-Whitney U testi kullanılarak karşılaştırıldı. ED ile ilişkili faktörleri ve optimal yırtık boyutu eşik değerini belirlemek için tek değişkenli lojistik regresyon ve alıcı işletim karakteristiği (ROC) analizleri kullanıldı. Postoperatif ED 10 hastada (%50,0) gelişti. ED gelişen hastaların hastaneye başvuru süresi ED gelişmeyenlere göre daha uzundu (medyan, 6,0'a karşı 3,5 saat; $p=0,005$). Tunika yırtık boyutunun $>1,8$ cm olması ED gelişen hastalarda daha sık görüldü (%70,0'a karşı %10,0; $p=0,020$). Hastaneye başvuru süresindeki her bir saatlik gecikme ED olasılığını yaklaşık 2,3 kat artırırken (OR=2,336, %95 GA: 1,049–5,202; $p=0,038$), $>1,8$ cm yırtık boyutu 21 kat daha yüksek ED olasılığı ile ilişkiliydi (OR=21,00, %95 GA: 1,77–248,10; $p=0,016$). ROC analizinde $>1,8$ cm yırtık boyutunun ED'yi AUC=0,765 (%95 GA: 0,528–1,000; $p=0,028$), %70,0 duyarlılık ve %90,0 özgüllük ile öngördüğü saptandı. Gecikmiş hastane başvurusu ve daha büyük tunika albuginea yırtık boyutu postoperatif ED ile ilişkiliydi. $>1,8$ cm yırtık boyutu, postoperatif risk sınıflandırmasında klinik olarak yararlı bir eşik değeri olabilir.

Anahtar Kelimeler: Eğitim seviyesi, Ereksiyon bozukluğu, Komplikasyon, Penil fraktür

Introduction

Penile fracture refers to the acute rupture of the tunica albuginea together with disruption of the corpus cavernosum during erection, and while relatively uncommon, it remains an urgent clinical condition requiring immediate recognition and intervention. Classically, patients describe a sudden cracking sound at the moment of injury, followed by severe pain, rapid loss of erection, and rapid progression of swelling and ecchymosis in the penile shaft (1). Although vigorous sexual intercourse—particularly positions wherein the penis slips and is forcefully bent—represents the most frequently reported etiology worldwide, other mechanisms such as intentional bending during masturbation, inadvertent trauma, or injuries occurring during nocturnal erections have also been identified. Importantly, the predominant mechanism varies across geographical regions and cultural backgrounds, suggesting that sexual behaviors and sociocultural norms influence the pattern of occurrence. For example, self-bending injuries are more frequently reported in certain Middle Eastern regions, while coitus-related fractures predominate in Western populations (2–6). In most cases, the corporal rupture is unilateral; however, bilateral injuries occur in roughly 10% of cases and these are more likely to be accompanied by urethral trauma (7,8). Coitus-related fractures typically occur along the ventrolateral surface of the penile shaft (9).

The diagnosis of penile fracture is typically clinical and can often be made based on patient history and physical examination alone. Patients usually report a clear snapping sensation, followed by immediate detumescence and bruising (10). If Buck's fascia remains intact, the resulting hematoma remains confined to the penile shaft and leads to the characteristic “eggplant deformity.” In contrast, rupture of Buck's fascia permits blood to track into the scrotum, perineum, or suprapubic area (11). Feelings of embarrassment or cultural stigma may contribute to delayed presentation in some patients, making prompt clinical evaluation essential to reduce complications. Urethral injury is most frequently associated with bilateral corporal rupture and may present with hematuria or difficulty voiding (12,13). While physical examination remains the cornerstone of diagnosis, ultrasonography can be employed in uncertain cases (8), and magnetic resonance imaging may provide superior visualization when available, though its routine use is often limited by cost and accessibility (14).

In addition to acute pain and deformity, penile fracture may result in long-term complications such as erectile dysfunction (ED), penile curvature, palpable fibrosis, or painful erections, all of which can significantly impair sexual function and quality of life (15). Early surgical intervention is widely accepted as the standard of care, as conservative management has been associated with higher rates of complications. Nevertheless, the reported incidence of postoperative ED varies considerably across studies. Proposed factors contributing to postoperative outcomes include the size and location of the tunical defect, the presence of associated urethral injury, delay before surgical repair, underlying comorbidities, and baseline erectile status (16). Delayed presentation in penile fracture has frequently been attributed to embarrassment, fear, and sociocultural attitudes toward genital trauma, which may discourage patients from seeking immediate medical attention (17). Educational level, as a surrogate marker of health literacy and socioeconomic status, may influence symptom recognition, healthcare-seeking behavior, and access to timely treatment. Although lower health literacy has consistently been associated with delayed healthcare utilization and poorer health outcomes across medical conditions, its role in penile fracture has received little attention. Furthermore, only a limited number of studies have explored educational level as a potential determinant of long-term functional outcomes after penile fracture repair (18).

Therefore, the present study aimed to evaluate the association of tunical tear size, time to hospital presentation, and educational level with postoperative erectile dysfunction following surgical repair of penile fracture.

Material and Method

Study Design

This study was conducted as a retrospective, single-center cohort analysis encompassing adult male patients aged 18 years and older who underwent surgical repair for penile fracture in a tertiary referral urology department between April 2023 and March 2025. Permission for the study was obtained from the Kocaeli City Hospital Ethics Committee on December 11, 2025 (Number: 2025-178), and informed consent was obtained for surgical treatment and subsequent retrospective evaluation where possible. To ensure consistency and reliability of the outcome assessment, 3 patients with insufficient clinical

documentation or follow-up periods shorter than six months were excluded from the study.

Data Collection

Demographic characteristics recorded included patient age and education level. Injury-related variables included the reported mechanism of trauma (sexual intercourse, forced manual intervention or masturbation, injury due to nocturnal erection, or other causes), time from injury to hospital admission (in hours), and symptoms such as audible cracking sound, penile pain, hematuria, or difficulty urinating. Documented physical examination findings included the classic "eggplant deformity" and palpable discontinuity in the tunica albuginea. Intraoperative parameters included the size of the tunica tear (measured in centimeters), whether the corporal rupture was unilateral or bilateral, whether flexible cystoscopy was performed in cases suspected of urethral involvement, and surgical time (measured in minutes). Postoperative erectile function was assessed using the IIEF-5 questionnaire administered during routine follow-up visits at approximately 6 months after surgery. For the present retrospective study, IIEF-5 scores were extracted from the patients' medical records. Complete postoperative IIEF-5 data were available for all 20 patients included in the final analysis. At 6 months postoperatively, patients were classified as having ED if their IIEF-5 score was ≤ 21 and as not having ED if their score was > 21 .

Surgical Technique

Surgical procedures were performed by experienced urologists using the same standardized surgical approach. All patients underwent surgery under either general or regional anesthesia. A standard subcoronal circumferential incision was made to deglove the penile shaft, allowing full exposure of the corporal bodies and tunica albuginea. After hematoma evacuation and complete exposure of the tunical defect, the maximum longitudinal dimension of the tunica albuginea tear was measured intraoperatively using a sterile ruler and recorded in centimeters. Defects were repaired using interrupted absorbable sutures such as 2-0 or 3-0 polyglactin, while carefully preserving neurovascular structures. In instances where clinical findings suggested concomitant urethral injury—such as blood at the

urethral meatus or voiding difficulty—flexible cystoscopy was carried out. To confirm the integrity of the repair and evaluate for residual curvature, an artificial erection was induced using intracavernosal saline.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Shapiro–Wilk test. Normally distributed variables were expressed as mean $\pm$ standard deviation (SD), whereas non-normally distributed variables were presented as median (minimum–maximum). Comparisons between two independent groups were performed using the Mann–Whitney U test for continuous variables that were not normally distributed. Categorical variables were compared using the two-sided Fisher's exact test because of the small sample size.

To identify factors associated with postoperative erectile dysfunction, univariate binary logistic regression analysis was performed, and the results were reported as odds ratios (OR) with 95% confidence intervals (95% CI). The discriminatory ability of tunica albuginea tear size for predicting postoperative erectile dysfunction was evaluated using receiver operating characteristic (ROC) curve analysis. The area under the ROC curve (AUC) with 95% confidence intervals was calculated, and the optimal cut-off value was determined using the Youden index. A two-sided p -value < 0.05 was considered statistically significant.

Results

A total of 20 patients were included in the study. The mean age of the patients was 42.6 ± 11.2 years. The median time to hospital presentation was 5.0 [2.0–11.0] hours, and the mean operative time was 69.25 ± 18.5 minutes. The median follow-up duration was 12 months (range, 6–26 months) (Table 1). Flexible cystoscopy was selectively performed in patients suspected of urethral injury based on clinical findings; however, no urethral tears were detected during surgery, and no patient required emergency urethral reconstruction.

Table 1. Baseline demographic, clinical, and operative characteristics of patients undergoing surgical repair for penile fracture

Variable	Value
Age (years); mean $\pm$ SD	42.6 $\pm$ 11.2
Time to presentation (hours); median [min–max]	5.0 [2.0–11.0]
Operation time (minutes); mean $\pm$ SD	69.3 $\pm$ 18.5
Follow-up duration (months); median [min–max]	12 [6–26]
Tunica tear size (cm); median [min–max]	1.7 [1.0–2.7]
Postoperative IIEF-5; median [min–max]	21.0 [12.0–25.0]
Educational level; n (%)	
- Below university level	11 (55.0%)
- University graduate	9 (45.0%)
Tunica tear size (cm); n (%)	
- $\leq$ 1.8	12 (60.0%)
- $>$ 1.8	8 (40.0%)
Erectile dysfunction; n (%)	
- Yes	10 (50.0%)
- No	10 (50.0%)

Penile fracture occurred during sexual intercourse in 14 (70%) patients, during vigorous masturbation in 4 (20%) patients, and during nocturnal erection in 2 (10%) patients. Regarding presenting symptoms, 11 (55%) patients reported hearing a cracking sound, while 9 (45%) patients presented primarily with sudden penile swelling.

Patients with erectile dysfunction at 6 months post-surgery presented to the hospital significantly

later than those without erectile dysfunction (median, 6.0 vs. 3.5 hours; $p=0.005$) (Table 2). Furthermore, tunica albuginea tear size greater than 1.8 cm was significantly more common in patients with postoperative erectile dysfunction compared to those without erectile dysfunction (70.0% vs. 10.0%, $p=0.020$).

Table 2. Comparison of clinical variables according to postoperative erectile function

Variable	ED Present (n=10)	No ED (n=10)	p-value
Educational Level; n (%)			0.070 ⁺
- Below university level	8 (80.0%)	3 (30.0%)	
- University graduate	2 (20.0%)	7 (70.0%)	
Tunica Tear Size (cm); n (%)			0.020 ⁺
- $\leq$ 1.8	3 (30.0%)	9 (90.0%)	
- $>$ 1.8	7 (70.0%)	1 (10.0%)	
Time to Presentation (hours); median [min–max]	6 [2.0–11.0]	3.5 [2.0–6.0]	0.005 ⁺⁺

⁺Fisher's exact test, ⁺⁺ Mann–Whitney U test

Patients with an education level below university presented to the hospital significantly later than university graduates (median, 6 vs. 3 hours, $p=0.001$). Although patients with less than a university education tended to have a higher rate of postoperative erectile dysfunction than university graduates (80.0% vs. 30.0%), this difference did not reach statistical significance ($p=0.070$) (Table 2).

Univariate logistic regression analysis showed that delayed presentation and larger tunica albuginea tear size were significant predictors of postoperative erectile dysfunction. Each additional hour before hospital admission increased the probability of postoperative erectile dysfunction

approximately 2.3-fold (OR=2.336, 95% CI: 1.049–5.202; $p=0.038$). Similarly, patients with tunica albuginea tears >1.8 cm were 21 times more likely to experience postoperative erectile dysfunction than those with tears ≤ 1.8 cm (OR=21.00, 95% CI: 1.77–248.10; $p=0.016$) (Table 3).

Table 3. Univariate logistic regression analysis of predictors of postoperative erectile dysfunction

Risk Factor	OR (% 95 CI)	p-value
Time to Presentation (hours)	2.336 (1.049-5.202)	0.038
Tear size >1.8 cm (Ref: ≤1.8 cm)	21.00 (1.77–248.10)	0.016

Ref: Reference, OR: Odds Ratio

Receiver operating characteristic analysis showed that tunica albuginea tear size had a good discriminative ability in predicting postoperative erectile dysfunction, with an area under the curve (AUC) of 0.765 (95% CI: 0.528–1.000; $p=0.028$). The optimal cut-off value determined by the Youden index was >1.8 cm, providing 70.0% sensitivity and 90.0% specificity (Figure 1).

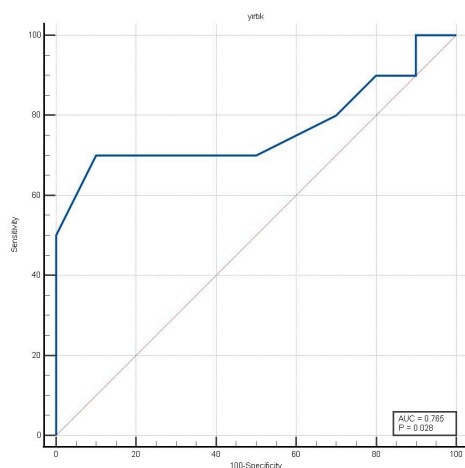


Figure 1. ROC curve analysis demonstrating tunica albuginea tear size prediction of postoperative ED (AUC 0.765, $p=0.028$)

Discussion

Penile fracture remains a true urological emergency, and prompt surgical intervention is widely accepted as the most appropriate approach to achieve favorable functional outcomes (19). The role of preoperative imaging remains controversial. Although imaging modalities may improve visualization of the tunical defect, they may also delay surgical intervention and increase healthcare costs. Therefore, similar to many high-volume centers, diagnosis in our institution is primarily based on patient history and physical examination without routine preoperative imaging.

Urethral injury has been reported in approximately 10–20% of penile fracture cases,

although its incidence varies considerably across different geographic regions. Studies from the Persian Gulf and Japan have reported relatively low rates of urethral injury (0–3%), whereas higher incidences have been described in European series (20–38%), probably reflecting differences in injury mechanisms and sexual practices (8,16). In the present study, no postoperative urethral stricture or clinically significant penile curvature developed during follow-up, supporting the effectiveness of immediate surgical repair.

The distribution of injury mechanisms in our cohort—70% during sexual intercourse, 20% during vigorous masturbation, and 10% during nocturnal erections—is consistent with reports from Western countries, whereas manual penile bending remains the predominant mechanism in several Middle Eastern and Central Asian populations (20). These differences most likely reflect regional sociocultural and behavioral factors influencing the etiology of penile fracture.

Previous studies have suggested that larger tunical defects are associated with poorer postoperative erectile outcomes, with reported rates of postoperative erectile dysfunction ranging from 0% to 34.6% (21). In another study, threshold values used to predict erectile dysfunction (ED) were found to be 18.5 mm for tunical defect size, 14.5 hours for time between fracture and surgery, and 41 years for age (22). Our findings support this observation. Patients with tunical tears >1.8 cm had significantly higher rates of postoperative erectile dysfunction than those with smaller tears ($p=0.020$). Furthermore, univariate logistic regression demonstrated that a tear size >1.8 cm increased the odds of postoperative erectile dysfunction by approximately 21-fold. ROC analysis also identified 1.8 cm as the optimal threshold for predicting postoperative erectile dysfunction, with an AUC of 0.765, a sensitivity of 70%, and a specificity of 90%. These findings suggest that tear size is not only associated with postoperative erectile function but may also serve as a clinically useful marker for postoperative risk stratification.

The relationship between treatment delay and postoperative erectile dysfunction remains controversial (23). While one study suggested that the risk of erectile dysfunction increases when the interval from hospital admission to surgery exceeds 8.2 hours (24), another found no significant differences among patients treated within 0–6, 6–12, or 12–24 hours after injury (25). In our study, patients with postoperative erectile

dysfunction presented significantly later than those without erectile dysfunction, and each additional hour before hospital presentation increased the odds of postoperative erectile dysfunction by more than twofold. These findings emphasize the importance of early presentation and timely surgical intervention for preserving postoperative erectile function.

The overall postoperative erectile dysfunction rate in our cohort was 50%, which is higher than that reported in several previous studies. Barros et al. and Hatzichristodoulou et al. reported postoperative erectile dysfunction rates of 13.1% and 30.8%, respectively (21,26). This discrepancy may be explained by differences in patient characteristics, baseline erectile function, surgical timing, operative techniques, follow-up duration, and methods used to assess erectile function. Moreover, several published studies lacked standardized postoperative functional assessment, limiting direct comparison across cohorts.

Although patients with lower educational attainment presented to the hospital significantly later than university graduates, educational level was not significantly associated with postoperative erectile dysfunction. The observed delay in hospital presentation among patients with lower educational attainment may reflect reduced awareness of penile fracture as a surgical emergency, embarrassment, sociocultural factors, or barriers to healthcare access. Improving public awareness of penile trauma and emphasizing the importance of prompt medical evaluation may help reduce delays in presentation and potentially decrease preventable long-term functional complications.

This study has several limitations. First, the retrospective design and relatively small sample size limit the generalizability of the findings and the precision of the estimated effect sizes. Second, pre-injury IIEF-5 scores were not available; therefore, postoperative erectile function could not be compared with baseline erectile status. Third, because postoperative ED was observed in only 10 patients, multivariable logistic regression analysis was not performed to avoid model overfitting and unstable coefficient estimates. Larger, prospective, multicenter studies are needed to validate the proposed 1.8 cm tear size threshold and further clarify the determinants of postoperative erectile dysfunction after penile fracture repair.

Conclusion

Penile fracture requires prompt surgical management to optimize long-term functional outcomes. Delayed hospital presentation and larger tunica albuginea tears were significantly associated with postoperative erectile dysfunction, while a tear size >1.8 cm demonstrated good diagnostic performance for identifying patients at increased risk of postoperative erectile dysfunction. These findings suggest that tunical tear size may serve as a practical intraoperative marker for postoperative risk stratification. Although lower educational attainment was associated with delayed presentation, its relationship with postoperative erectile dysfunction was not statistically significant. Public education aimed at improving awareness of penile fracture and encouraging early medical consultation may contribute to improved functional outcomes. Prospective multicenter studies with larger patient populations are needed to validate these findings.

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Conflict of interest statement

No conflict of interest was declared by the authors.

Ethics Committee Approval

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