Research article

Surgical outcomes in penile fractures: A single center experience in China

Jun Zhu [a,b,c,1], Yuan Tang [a,b,c,1], Sainan Zhu [d,1], Jianming Kang [e], Weidong Song [a,b,c], Wanshou Cui [a,b,c], Yiming Yuan [a,b,c], Zhichao Zhang [a,b,c], Jing Peng [a,b,c,*]

[a] *Andrology Center, Peking University First Hospital, Beijing (100034), China. No. 8 Xishiku St, Xicheng District, Beijing, 100034, China*
[b] *Department of Urology, Peking University First Hospital, No. 8 Xishiku St, Xicheng District, Beijing, 100034, China*
[c] *Institute of Urology, Peking University, National Urological Cancer Center, No. 8 Xishiku St, Xicheng District, Beijing, 100034, China*
[d] *Statistics Department of Peking University First Hospital, No. 8 Xishiku St, Xicheng District, Beijing, 100034, China*
[e] *Department of Urology, Xiangtan County People's Hospital, Xiangtan, Hunan, 411200, China*

ABSTRACT

Introduction: Penile fracture is an uncommon urological emergency resulting from tunica albuginea rupture during penile erection. It is a rare condition requiring urgent surgery. Despite immediate surgical repair, the patients' erectile functions may still be impacted by penile fracture. This study aims to investigate the efficacy of surgical repair in penile fractures and its impact on erectile function.
Methods: Our cohort was composed of patients diagnosed with penile fractures and received surgical repair from September 2014 to August 2022 in Peking University First Hospital. Penile color Doppler ultrasound confirmed the diagnosis. Surgical exploration was conducted, and postoperative complications were evaluated during follow-up. Erectile function was assessed using the International Index of Erectile Function-5 (IIEF-5) score. Univariate analysis was conducted employing the chi-square test, *t*-test, and Mann-Whitney *U* test to identify factors that may impact postoperative erectile function. Furthermore, multivariate analysis was conducted using logistic regression and linear regression to determine the independent risk factors influencing postoperative erectile function.
Results: A total of 58 patients were enrolled in our study. The majority of injuries (69.0 %, 40/58) resulted from vigorous sexual intercourse. Most of the patients (69.0 %, 40/58) presented within 24 h. Sixteen patients (27.6 %) presented with concomitant urethral injury. The median size of the tunical tear was 1.5 (IQR, 1.0–2.0) cm. Presentation delay correlated significantly with the difference in IIEF-5 score before and after surgery, with corresponding p values of 0.028. Urethral injury correlated significantly with postoperative erectile dysfunction (ED), postoperative IIEF-5 score, and the difference in IIEF-5 score before and after surgery, with corresponding p values of 0.002, 0.004, and 0.002, respectively.
Conclusions: To conclude, surgical repair of penile fracture provides good functional results with few morbidities and urethral injury may adversely affect postoperative erectile function after penile fracture repair.

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* Corresponding author. Andrology Center, Peking University First Hospital, Beijing (100034), China. No. 8 Xishiku St, Xicheng District, Beijing, 100034, China.
E-mail address: pengjing@bjmu.edu.cn (J. Peng).
[1] These authors contributed equally to this work.

1. Introduction

Penile fracture is an uncommon urological emergency, characterized by the traumatic tearing of the tunica albuginea of the corpora cavernosa due to rotational or bending forces during penile erection [1]. Its reported incidence is roughly 1 in 175,000 [2]. Penile fracture often happens during vigorous sexual intercourse, although noncoital causes like masturbation, blunt trauma, and the "Taghaandan" maneuver have also been documented [3,4]. Patients often report an audible popping sound during sexual activity, followed by immediate penile pain, swelling, and hematoma formation, resulting in the characteristic "eggplant deformity" [5]. Additionally, concurrent corporal rupture and/or urethral injury may occur, thereby requiring specialized treatment. Fear and embarrassment of patients often lead to delay in seeking medical attention, potentially causing poor cosmetic and long-term functional complications. Therefore, the actual incidence of penile fracture might be higher than previously reported [6].

Historically, conservative management was the prevailing approach in the management of penile fractures. However, it exhibited an incidence of complications in up to 50 % of patients, including penile curvature, palpable nodules, erectile dysfunction (ED) and so on. Therefore, immediate surgical repair is now considered the primary therapeutic strategy because it has better long-term outcomes than conservative treatment [7–9]. According to reports, the occurrence rate of ED after surgical repair of penile fractures varies between 0 % and 12 %. ED is the primary concern following surgical repair of a penile fracture, given its potential to impose severe physical and psychological harm on the patient [7]. However, to date, there have been only a few reports on the risk factors for erectile dysfunction following surgical repair of a penile fracture. The main aim of our research is to investigate the efficacy of surgical repair in penile fractures and its impact on erectile function.

2. Methods

The research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki. The present study protocol was reviewed and approved by the Institutional Review Board of our hospital (approval No. 2023281). Informed consent was obtained by all subjects when they were enrolled. All the patients with a confirmed penile fracture and received surgical repair from September 2014 to August 2022 were included. The diagnosis of the penile fracture was confirmed via penile color Doppler ultrasound (CDU), medical history, and physical examination. The baseline parameters and clinical data of the patients were retrieved from the medical records. The demographic data, etiology of injury, time of presentation, examination results, and intraoperative findings were retrospectively recorded. Patients were followed up by telephone. The patients were initially assessed for acute complications, including wounds infection, hematoma, skin necrosis and so on. During subsequent follow-up, occurrence of chronic complications was evaluated, such as plaque, nodules, and penile curvature. Erectile function assessments were conducted using standard questionnaires. The International Index of Erectile Function-5 (IIEF-5) score was utilized for the diagnosis and grading of ED [10]. The pre- and post-operative IIEF-5 scores were obtained from patient follow-up after the operation. Patients with an IIEF-5 score less than 22 were diagnosed with ED. All patients underwent surgical exploration through a subcoronal degloving incision or local incision of the penile shaft based on the wound location indicated by CDU. Statistical analysis was conducted using SPSS (version 24.0, IBM, Armonk,
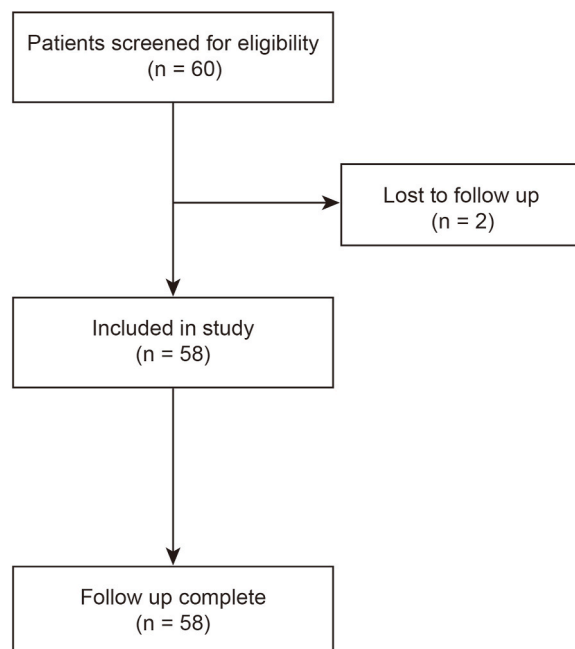

Fig. 1. Flowchart of enrolling patients with penile fractures.

NY). Univariate analysis was performed employing the chi-square test, *t*-test, and Mann-Whitney *U* test to identify factors that may impact postoperative erectile function. We conducted collinearity analysis for all independent variables. Furthermore, multivariate analysis was conducted utilizing logistic regression and linear regression to identify the independent risk factors influencing postoperative erectile function, and p < 0.05 was deemed statistically significant.

3. Results

Our cohort was composed of 58 patients who were diagnosed with penile fracture. The flow diagram is shown in Fig. 1. The baseline characteristics of the patients are listed in Table 1. The mean age of the patients at presentation was 41.9 ± 9.5, ranging from 24 to 64 years. The time between trauma and presentation ranged from 4 h to 4 days, with the majority of the patients (69.0 %, 40/58) presented within 24 h. Of the enrolled patients, 69.0 % (40/58) of injuries were attributed to sexual intercourse, 3 injuries (5.2 %) resulted from penile fracture during masturbation, 6 cases (10.3 %) were sustained while rolling over the erect penis in bed in the morning, 8 (13.8 %) were caused by direct blunt trauma, and 1 case was due to sharp injury. None of the enrolled patients had a pre-existing history of ED as determined retrospectively using the IIEF-5 questionnaire. Sixteen patients (27.6 %) presented with concomitant urethral injury. The median size of the tunical tear was 1.5 (IQR, 1.0–2.0) cm. A proximal shaft tear was found in 25 (43.1 %) patients, a mid-shaft injury in 27 (46.6 %), and a tear in the distal shaft in 6 patients (10.3 %). A total of 16 (27.6 %) patients had a tunical tear on the right corpus cavernosum, 35 (60.3 %) had a tunical tear on the left corpus cavernosum, and 7 (12.1 %) had bilateral tears.

In the early postoperative period, no patients experienced complications including wound infection or skin necrosis. The mean IIEF-5 scores were 24.3 ± 0.9 before surgery and 22.1 ± 1.9 six months after surgery. A total of 18 (31.0 %) patients demonstrated evidence of ED, 14 (24.1 %) had penile curvature on erection that was <10° but did not affect penetration during sexual intercourse, and 10 (17.2 %) patients complained of painful erection. On examination, small penile nodules measuring >5 mm were found in 8 (13.8 %) patients. None of the patients had plaques or difficulty performing during sexual intercourse owing to nodules. We performed a univariate analysis of the included variables, and only the correlation between urethral injury and ED, postoperative IIEF-5 score, and the change in IIEF-5 score before and after surgery was statistically significant (shown in Table 2). Moreover, it remained statistically

Table 1
Clinical characteristics of patients.

Characteristics	Mean ± SD/Median (IQR)/n (%), n = 58
Age (years)	41.9 ± 9.5
Etiology	
Masturbation	3 (5.2)
Sexual intercourse	40 (69.0)
Rolling over in bed	6 (10.3)
Direct blunt trauma	8 (13.8)
Sharp injury	1 (1.7)
Duration from trauma to surgery (h)	24(IQR, 12–45)
Defect length (mm)	1.7 ± 0.9
Defect localization	
Proximal shaft	25 (43.1)
Midshaft	27 (46.6)
Distal shaft	6 (10.3)
Defect side	
Right	35 (60.3)
Left	16 (27.6)
Bilateral	7 (12.1)
Urethral injury	
Yes	16 (27.6)
No	42 (72.4)
Presentation delay >24 h	
Yes	18 (31.0)
No	40 (69.0)
Penile curvature after surgery	
Yes	14 (24.1)
No	44 (75.9)
Painful intercourse after surgery	
Yes	10 (17.2)
No	48 (82.8)
Erectile function before penile fracture	
IIEF-5 score	24.3 ± 0.9
ED	0
Erectile function 6 months after surgery	
IIEF-5 score	22.1 ± 1.9
ED	18 (31.0)

Abbreviations: SD, Standard deviation; IQR, interquartile ranges; IIEF-5, International Index of Erectile Function; ED, erectile dysfunction.

significant in the multivariate analysis, with corresponding p values of 0.002, 0.004, and 0.002, respectively (shown in Tables 3–5). Presentation delay correlated significantly with the difference in IIEF-5 score before and after surgery, with corresponding p values of 0.028.

4. Discussion

4.1. Clinical characteristics of penile fracture

In the non-erect state, the thickness of the tunica albuginea is roughly 2 mm. However, during erection, the tunica albuginea experiences a significant reduction in thickness to a range of 0.25–0.50 mm due to the pronounced increase in intracavernosal pressure [11]. Consequently, trauma occurring while the penis is in an erect state poses a higher risk of penile fracture. Under normal circumstances, pressures resulting from trauma exceeding 1500 mmHg may lead to the rupture of the penile corpora cavernosa [12]. Previous studies have demonstrated that the most prevalent causes of penile fracture include sexual intercourse (46 %), forced curvature (21 %), and masturbation (18 %) [2]. Penile fractures typically occur when the penis accidently impacts the perineum or pubic symphysis during sexual intercourse [13]. However, the causes of penile fractures can vary regionally. In the United States and Western European countries, sexual intercourse remains the leading cause of penile fracture, whereas in the Middle East, Gulf region, and North Africa, manual penile manipulation for detumescence is more commonly associated [3,4,14,15]. In our study, the two most common etiologies of penile fracture were sexual intercourse (69.0 %, 40/58) and blunt force trauma (13,8 %, 8/58). Our study did not find any association between the cause of penile fractures and postoperative erectile function. Penile fractures are most commonly observed on the right side of the penis [16,17]. Consistent with the existing literature, our study revealed that 67 % of patients presented with penile fractures on the right side. Some studies linked this to the higher proportion of right-handed patients in the study population, thus resulting in a higher prevalence of tunical tears on the right side during penile manipulation [5]. Previous studies have presented conflicting findings concerning the predominant site of penile injury. Some studies have indicated that the proximal third of the penis is the most frequently affected region, while others have identified the midshaft as the predominant location of injury [5,18–20]. In our study, we observed that midshaft injuries were the most prevalent. This finding is understandable as the tunica albuginea, which is relatively thinner in the midshaft, is more vulnerable during the process of erection.

4.2. Potential factors influencing erectile function following surgical repair of penile fracture

ED after surgery is a significant complication following penile fracture [4]. The incidence of ED after surgical treatment for penile fractures varies notably across different studies. Some studies indicate that more than half of penile fracture patients experience varying degrees of ED, while other studies report a low occurrence rate of ED [4,6,21]. Differences in incidences may be linked to the preoperative erectile function of the patients. There is still debate about whether delayed repair will affect the patient's postoperative erectile function. Studies have reported that early or immediate surgical intervention can minimize the risk of long-term complications [21,22]. In a retrospective multicenter study, surgical repair within the first 8.23 h can reduce the risk of postoperative ED [23]. However, it was also reported that repair delayed for 24–40 h has no negative impact on the patient's erectile function [24]. Although presentation delay correlated significantly with the difference in IIEF-5 score before and after surgery, it was not an independent risk factor for postoperative ED in our study. Despite the limited sample size in this study, the findings are consistent with previous investigations. A retrospective review of 12 studies involving 503 patients revealed that presentation delay was not correlated significantly with the incidence of ED [25]. In addition, a retrospective study identified an increased risk for postoperative ED in patients who are over 50 years old at the time of injury and have bilateral corporal involvement [18]. However, our results show that neither of these factors are associated with ED, which is consistent with a retrospective study involving the clinical data of 138 patients [26].

According to reported studies, approximately 6 %–38 % of penile fractures are accompanied by urethral injury [2,21,27]. The likelihood of concurrent urethral injury is higher in European countries compared to Asian countries [28]. The lower prevalence of associated urethral injuries in Asian patients is not yet fully understood. However, it has been reported that a significant number of penile fractures in the Middle East are linked to the widespread practice of "taghaandan", characterized by low-energy trauma with a minimal risk of urethral injuries [29,30]. In our study, we observed urethral injuries in 16 cases (27.6 %), which is higher than the reported incidence in most Asian countries. This disparity may be attributed to the predominant mechanisms of injury in our study,

Table 2
Univariate analysis for risk factors of postoperative sexual function.

	p-value		
	postoperative ED.	postoperative IIEF-5 score	the difference in IIEF-5 scores before and after surgery
Age	0.614	0.437	0.372
Presentation delay	0.395	0.129	0.095
Unilateral or bilateral	0.219	0.194	0.052
Defect localization	0.639	0.339	0.628
Defect length	0.237	0.059	0.249
Urethral injury	<0.001*	0.001*	<0.001*

Abbreviations: ED, erectile dysfunction; IIEF-5, International Index of Erectile Function. *p < 0.05.

Table 3

Multivariate analysis for risk factors of postoperative ED.

	OR	95%CI	p-value
Age	1.004	0.930-1.083	0.922
Presentation delay	2.909	0.659-12.846	0.159
Unilateral or bilateral	2.875	0.349-23.705	0.326
Defect localization			0.669
Proximal shaft	Reference group		
Midshaft	1.085	0.227-5.179	0.919
Distal shaft	0.340	0.023-4.959	0.430
Defect length	1.706	0.710-4.098	0.232
Urethral injury	11.330	2.530-50.733	0.002*

Abbreviations: ED, erectile dysfunction; OR = odds ratio, CI = confidence interval. $p < 0.05$*.

Table 4

Multivariate analysis for factors influencing postoperative IIEF-5 score.

	B	β	t	p-value
Age	−0.014	−0.068	−0.554	0.582
Presentation delay	−0.932	−0.228	−1.991	0.062
Unilateral or bilateral	−0.931	−0.169	−1.358	0.181
Defect localization	−0.293	−0.101	−0.789	0.434
Defect length	−0.416	−0.191	−1.502	0.139
Urethral injury	−1.586	−0.374	−3.000	0.004*

Abbreviations: IIEF-5, International Index of Erectile Function. $p < 0.05$*.

Table 5

Multivariate analysis for factors influencing the difference in IIEF-5 scores before and after surgery.

	B	β	t	p-value
Age	0.016	0.101	0.843	0.403
Presentation delay	0.863	0.263	2.262	0.028*
Unilateral or bilateral	1.041	0.236	1.940	0.058
Defect localization	0.170	0.073	0.586	0.560
Defect length	0.191	0.109	0.881	0.382
Urethral injury	1.363	0.401	3.296	0.002*

Abbreviations: IIEF-5, International Index of Erectile Function. $p < 0.05$*.

mainly sexual intercourse and accidental blunt trauma, both of which are considered high-energy trauma. Our findings revealed that urethral injury had a detrimental effect on post-repair erectile function in individuals with penile fractures. In penile fracture patients with a concomitant urethral injury, the postoperative IIEF-5 scores were notably lower than their preoperative IIEF-5 scores, demonstrating a more pronounced decline. Additionally, there was a higher proportion of individuals who experienced ED after the repair procedure.

4.3. Limitations

Admittedly, the present study was not devoid of limitations. Firstly, this study is retrospective in design, which led to an inevitable selection bias. Secondly, the study only enrolled patients who underwent surgical treatment, excluding those who received conservative management, which created a biased series overall. It should also be noted as a limitation that the follow-up duration is 6 months, which is relatively short, and the long-term recovery of erectile function remains unclear. Finally, this study was conducted within a single hospital, with a relatively small sample size, warranting further research with a larger sample for validation.

5. Conclusions

To conclude, penile fracture is a urological emergency, and surgical repair provides good functional results with few morbidities. The present study revealed that the presence of a concurrent urethral injury has an adverse impact on postoperative erectile function in patients with penile fractures.

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Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding authors on reasonable request.

CRediT authorship contribution statement

Jun Zhu: Writing – review & editing, Writing – original draft, Formal analysis, Data curation. **Yuan Tang:** Writing – review & editing, Writing – original draft, Data curation. **Sainan Zhu:** Writing – review & editing, Formal analysis. **Jianming Kang:** Writing – review & editing, Data curation. **Weidong Song:** Writing – review & editing, Project administration. **Wanshou Cui:** Writing – review & editing, Project administration. **Yiming Yuan:** Writing – review & editing, Project administration. **Zhichao Zhang:** Writing – review & editing, Project administration. **Jing Peng:** Writing – review & editing, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Abbreviations:

ED	erectile dysfunction
CDU	color Doppler ultrasound
IIEF-5	International Index of Erectile Function
SD	Standard deviation
IQR	interquartile ranges
OR	odds ratio
CI	confidence interval

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