



Open Access

ORIGINAL ARTICLE

Sexual Function

Risk factors for penile fracture compared with a surgical control cohort in the United States: the role of substance abuse

Nathaniel Christian-Miller¹, Andrew T Lenis², Katherine E Fero², Josef Madrigal¹, Sriram V Eleswarapu², Karim Chamie², Peyman Benharash¹

Penile fracture (PF) is a surgical emergency. Given its rarity, we queried a national cohort over an 11-year period to study the temporal and demographic variations in presentation, evaluation, and management of patients with PF compared with a cohort of control patients. The National Inpatient Sample was queried between the years 2005 and 2016 for patients with a diagnosis of PF. Appendectomy patients were selected as a control cohort, given the non-discriminatory nature of this disease. Clinical and demographic data of the patients were compared with that of controls. Presenting symptoms, rates of surgical repair, and rates of associated surgical procedures were evaluated in the PF cohort. During the study period, 5802 patients were hospitalized for PF. The annual incidence of PF remained unchanged at 1.0–1.8 cases per 100 000 hospitalizations over the study period. Compared with the control cohort, PF patients were more likely to be younger (38.7 years vs 41.2 years, $P \leq 0.001$), have lower rates of comorbidities except erectile dysfunction (1.4% vs 0.1%, $P \leq 0.001$), and were more likely of Black race (25.4% vs 6.2%, $P \leq 0.001$). Notably, PF patients had significantly higher rates of substance abuse (26.4% vs 18.1%, $P \leq 0.001$), despite no difference in the diagnosed psychiatric disorders. PF rarely presented with hematuria (3.5%); however, urethral evaluation was performed in 23.1%, most commonly with cystoscopy (19.2%). PF occurs more commonly in a younger, healthier male population, and among minorities. Importantly, rates of substance abuse appear to be higher in the PF cohort compared with those of controls.

Asian Journal of Andrology (2021) 23, 236–239; doi: 10.4103/aja.aja_70_20; published online: 27 November 2020

Keywords: epidemiology; penile fracture; penis; urethra; urethral injury

INTRODUCTION

Penile fracture (PF) is an uncommon but morbid urologic emergency requiring prompt evaluation and surgical intervention.¹ PF occurs when the erect penis is bent by a mechanical force, resulting in a tear in the tunica albuginea of the corpora cavernosa. This generally results in an audible snap and abrupt detumescence with associated pain and hematoma formation. Guidelines from the American Urological Association (AUA), the European Association of Urology (EAU), and the British Association of Urological Surgeons (BAUS) all state that a history and physical examination consistent with PF is sufficient for surgical exploration and repair.^{2–4} Imaging modalities to confirm the diagnosis, including magnetic resonance imaging (MRI) and ultrasound, have been described and may be helpful in equivocal cases; however, the routine use of imaging remains controversial at present and is not routinely recommended.^{5,6}

The effects of PF can adversely impact the quality of life. Details regarding the timing of surgical repair on erectile function remain controversial, but nevertheless can have lasting and profound psychosocial effects.^{7–9} Therefore, understanding the patient's presentation and diagnosis is critical to improving the delivery of care and outcomes. In the last few years, several investigators

have published series on PF that are country specific, treatment focused for a small cohort, or focused on emergency department settings.^{10–12} These are largely retrospective analyses that do not contextualize PF with respect to other surgical emergencies. To address this gap in knowledge, we sought to characterize the temporal and demographic variations in the incidence, diagnostic evaluation, and surgical management of patients with penile fracture by performing a comparison to a control cohort of male patients admitted for appendectomy, a disease that indiscriminately affects the general population. We elected to focus on a large database of admitted patients to supplement the existing literature on emergency department patients, thereby adding robustness to what is known about the surgical acuity of PF.

PATIENTS AND METHODS

Study cohort

The 2005–2016 National Inpatient Sample (NIS) was used to identify men ≥ 18 years of age hospitalized with a diagnosis of corpora cavernosum PF. The NIS is a nationally representative all-payer inpatient care database maintained by the Agency for Healthcare Research and Quality's (AHRQ) Healthcare Cost and Utilization

¹Cardiovascular Outcomes Research Laboratories (CORELAB), Department of Surgery, David Geffen School of Medicine at UCLA, Los Angeles, CA 90095, USA;

²Department of Urology, David Geffen School of Medicine at UCLA, Los Angeles, CA 90095, USA.

Correspondence: Dr. KE Fero (kfero@mednet.ucla.edu)

Received: 13 July 2020; Accepted: 13 September 2020

Project (HCUP). The database provides accurate estimates for more than 35 million hospitalizations in the United States each year based on a 20% sampling methodology.

Independent variables and outcomes of interest

We used the International Classification of Diseases, Ninth Revision – Clinical Modification (ICD-9-CM) and ICD-10-CM to identify all adults admitted with a diagnosis of PF (ICD-9: 959.13, ICD-10: S39840A). We used male appendectomy as a comparison group to identify patient characteristics of significance associated with PF. Appendectomy was chosen due to its widespread and less discriminatory nature as compared to other surgically managed diagnoses. Thus, we identified men ≥ 18 years of age admitted with a diagnosis of appendicitis (ICD-9: 540.x, 541, 542; ICD-10: K35.x, K36, K37) and selected those who also underwent appendectomy. Patients with a diagnosis of PF were excluded from the appendectomy cohort.

Patient characteristics of interest included age, race, income quartile, payer status, substance abuse, psychiatric disorders, and other comorbidities (Table 1). Hospital characteristics included region, size, and teaching status. The outcomes of interest were clinical and demographic variables associated with PF compared with the control cohort of appendectomy patients, and trends in incidence, presentation, operative management, and urethral evaluation in the PF cohort.

Statistical analyses

Data were analyzed using Stata 15.1 software (Stata Corp., College Station, TX, USA). Sample sizes in this study were based on national estimates performed by Stata's survey command. This command takes the NIS' stratified cluster design and individual hospital's discharge-level weights into account. Categorical variables were compared using the Pearson's Chi-square test and continuous variables were compared using a two-tailed *t*-test. Cost of admission was determined based on HCUP's cost-to-charge ratio, which allows for translation of hospital charges into actual costs using hospital-specific ratios. Costs were adjusted based on the 2016 gross domestic product (GDP). Statistical significance was defined as $P < 0.05$.

Ethics statement

This is a retrospective cohort study that was performed using a publicly available, nationwide, clinical database. The study was deemed exempt, and informed consent was waived by the Institutional Review Board at the University of California (Los Angeles, CA, USA).

RESULTS

A total of 5802 patients were admitted with PF during the study period. The annual incidence of PF per 100 000 hospitalizations remained unchanged over the study period (Figure 1). Patient and hospital characteristics for PF and appendectomy inpatients are shown in

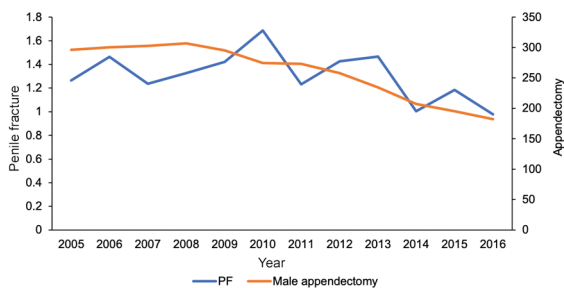


Figure 1: PF and appendectomy incidence per 100 000 hospitalizations. PF: penile fracture.

Table 1. Compared with the control appendectomy cohort, the PF cohort was significantly younger (38.7 years vs 41.2 years, $P \leq 0.001$),

Table 1: Cohort characteristics

Characteristics	Appendectomy for appendicitis in males (n=1 159 776)	Penile fracture (n=5802)	P
Age (year), mean	41.2	38.7	<0.001
Substance abuse			
Overall (%)	18.1	26.4	<0.001
Alcohol (%)	3.6	6.4	<0.001
Nicotine (%)	15.9	22.6	<0.001
Other drugs (%)	1.7	5.6	<0.001
Psychiatric disorders			
Depression (%)	3.0	3.5	0.27
Psychoses (%)	0.4	0.4	0.92
Bipolar disorder (%)	0.7	0.8	0.77
Schizophrenia (%)	0.3	0.3	0.89
Other comorbidities			
Erectile dysfunction (%)	0.1	1.4	<0.001
Congestive heart failure (%)	1.8	0.2	<0.001
Coronary artery disease (%)	5.5	2.0	<0.001
Chronic pulmonary disease (%)	6.7	4.9	0.01
Peripheral vascular disease (%)	1.2	0.1	<0.001
Liver disease (%)	1.6	0.7	0.02
Renal failure (%)	2.1	0.5	<0.001
Diabetes (%)	7.3	2.6	<0.001
Race			
White (%)	55.1	42.3	<0.001
Black (%)	6.2	25.4	<0.001
Asian (%)	2.8	1.4	0.005
Hispanic (%)	17.2	13.5	0.002
Income quartile			
0–25 (%)	21.5	28.5	<0.001
26–50 (%)	21.8	22.5	0.57
51–75 (%)	22.4	20.9	0.22
76–100 (%)	22.5	17.4	<0.001
Payer status			
Medicare (%)	12.5	5.3	<0.001
Medicaid (%)	10.0	14.1	<0.001
Private (%)	55.0	43.6	<0.001
Self-pay (%)	15.6	28.0	<0.001
Hospital location			
Urban teaching (%)	42.5	61.3	<0.001
Urban nonteaching (%)	44.8	35.2	<0.001
Rural (%)	12.3	3.5	<0.001
Hospital region			
Northeast (%)	20.7	24.7	0.002
Midwest (%)	19.0	14.5	<0.001
South (%)	35.4	37.1	0.2723
West (%)	24.8	23.7	0.4715
Hospital bed size			
Large (%)	57.1	69.0	<0.001
Medium (%)	27.6	21.4	<0.001
Small (%)	15.0	9.6	<0.001
Age bracket (year)			
≥ 75 (%)	4.3	0.4	<0.001
50–75 (%)	24.6	14.3	<0.001
<50 (%)	71.1	85.2	<0.001

had lower rates of all comorbidities (congestive heart failure, coronary artery disease, chronic pulmonary disease, peripheral vascular disease, liver disease, renal failure, and diabetes; all $P < 0.05$) except erectile dysfunction (1.4% vs 0.1%, $P \leq 0.001$), and were more likely of Black race (25.4% vs 6.2%, $P \leq 0.001$) (Figure 2). Patients with PF also disproportionately represented the lowest income quartile (28.5% vs 21.5%, $P \leq 0.001$) and had lower rates of private insurance (43.6% vs 55.0%, $P \leq 0.001$). A greater fraction of PF patients were admitted to urban teaching (61.3% vs 42.5%, $P \leq 0.001$) and large bed-size hospitals (69.0% vs 57.1%, $P \leq 0.001$) relative to the appendectomy cohort. Of note, 8.7% of the PF patients admitted and treated at an urban teaching hospital were transferred from another facility.

Comorbid substance abuse was significantly greater among penile fracture versus appendectomy patients (26.4% vs 18.1%, $P \leq 0.001$). Patients with PF were more likely to suffer from alcohol (1.8 \times), nicotine (1.4 \times), and other drug (3.3 \times) abuse (a composite of cannabis, opioids, sedatives, amphetamines, cocaine, inhalants, and hallucinogens), as shown in Figure 2. There was no significant difference in the prevalence of diagnosed psychiatric disorders between the cohorts.

Presentation, urethral evaluation, operative procedures, and outcomes are shown in Table 2. Of the urologic complaints captured by diagnosis code, hematuria was rarely documented (203/5802 patients, 3.5%); urinary retention was similarly infrequently documented (139/5802 patients, 2.4%). Urethral evaluation was performed in 1340/5802 (23.1%) patients, most commonly using cystoscopy (1114/5802 patients, 19.2%). The operative repair rate of penile fracture

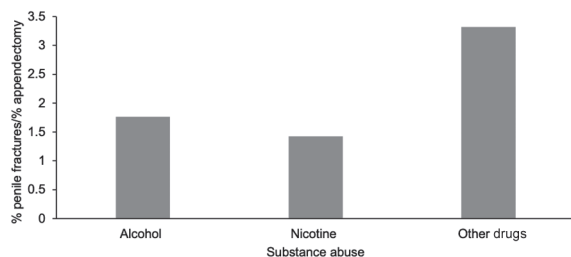


Figure 2: Nicotine, alcohol, and other drugs use in PF patients normalized to appendectomy cohort patients. PF: penile fracture.

Table 2: Presentation and urethral evaluation

Clinical variable	Penile fracture (n=5802)
Presenting symptoms (%)	
Hematuria	3.5
Lower urinary tract symptoms	0.4
Urinary retention	2.4
Diagnostic procedures (%)	
Cystoscopy/urethroscopy	19.2
Cystogram/cystourethrogram	4.6
Operative procedures (%)	
Overall operative rate	91.1
Repair of penis or prepuce	82.3
Circumcision	9.1
Urethral repair	17.3
Other operations on penis (penile shunt and irrigation of corpus cavernosum)	7.1
Suprapubic tube placement	1.8
Outcomes	
Adjusted cost (US dollar), mean	5916
Length of stay (day), mean (range)	1.4 (1.29–1.56)

at index admission was 91.1% and remained unchanged over the study period. Urethral repair was performed in 19.0% of patients (1004/5286 patients), circumcision in 10.0% of patients (528/5286 patients), and suprapubic tube placement was coded as a separate procedure among 2.0% of patients (104/5286 patients). The mean adjusted personal health-care cost for penile fracture was 5916 (median = 5134, interquartile range [IQR]: 3942–6585) US dollars and increased from 5084 US dollars in 2005 to 6609 US dollars in 2016 ($P = 0.01$). The mean length of stay was 1.4 (median = 1, IQR: 1–2) days and remained unchanged over the study period.

DISCUSSION

Penile fracture is an acute urologic emergency that is generally diagnosed by history and clinical examination and requires prompt surgical intervention. Given the infrequency in presentation, case series are generally limited and epidemiologic data from large databases and registries may provide novel insights. In this study, we evaluated the presentation, workup, and management of PF in a cohort of hospitalized patients from the National Inpatient Sample between the years 2005 and 2016. Our findings with respect to evaluation of the urethra and treatment patterns of any concomitant urethral injury are in line with previously reported US data, with approximately one-quarter of patients undergoing urethral evaluation with direct inspection or fluoroscopic examination and approximately one-fifth of patients undergoing urethral repair.¹³ The most significant and novel finding of our study is the association between substance abuse and PF. We also confirmed several demographic and socioeconomic associations with PF that remained significant when compared with that of a control cohort of male appendectomy patients. The implications of these findings inform the management and counseling of patients with PF, specifically regarding postoperative pain management and substance abuse screening.

Compared with a control cohort of male patients undergoing appendectomy, patients who were admitted for PF had significantly higher rates of substance abuse, including nicotine, alcohol, and other drugs. Few have reported substance abuse as a risk factor for PF. In a study evaluating over 8000 emergency room visits for suspected PF, drug and alcohol abuse were more common in the patients admitted for surgical repair.¹² While not evaluating PF *per se*, other studies have evaluated the behavior associated with substance abuse that promotes penile injury that ultimately leads to surgical intervention.¹⁴ In a *post hoc* analysis, we found no association with substance abuse and more severe injuries (*i.e.*, urethral injuries). Two possible explanations exist for the association between substance abuse and PF. First, as suggested by Rodriguez *et al.*,¹² it is possible that substance abuse predisposes to suboptimal penile erection and/or more vigorous intercourse, leading to increased risk of PF. Second, substance abuse may increase risk-taking behavior, which is associated with the development of PF. For example, one retrospective study of 16 patients found that half of the cases occurred during an extramarital affair, and the majority of these occurred “outside of the bedroom” (*e.g.*, car, elevator, workplace, and public restroom).¹⁵ Regardless of the pathophysiologic mechanism, there are potential management and counseling implications of these findings. While pain control is paramount in any postoperative setting, it is important to consider patient-specific comorbidities including potentially higher rates of substance abuse. Furthermore, PF in the setting of substance abuse could be used as an avenue to refer patients for counseling and management.

In our study, patients with PF were significantly younger, were more likely of Black race, had fewer medical comorbidities, and were

admitted more commonly to urban teaching hospitals, compared with a control cohort of male patients undergoing appendectomy. A minority of penile fracture patients treated at urban teaching hospitals were the result of a transfer from another facility; this can be explained by the accessibility of urologic care as opposed to general surgery services. Other studies have found similar trends. For example, looking specifically at patients with severe injuries (*i.e.*, PF with urethral injuries), Pariser *et al.*¹³ found that patients with more severe injuries were of Black race and were treated at large teaching hospitals. In this series, older age was associated with urethral injury, whereas in our series, patients with PF were younger than our control population of appendectomy patients. In general, PF patients are younger and have lower rates of all medical comorbidities except for erectile dysfunction. This finding was corroborated by Rodriguez *et al.*¹² in a series of emergency room patients. While initially counterintuitive, it is possible that patients with erectile dysfunction are likely to develop an injury during vigorous intercourse with a suboptimal erection.

Finally, we attempted to evaluate the rates of diagnostic imaging performed in the workup for suspected PF. We utilized codes for ultrasound and MRI which we believed would capture imaging performed to confirm the diagnosis. Rates during the study period remained extremely low (approximately 1%). This is in concordance with the AUA, EAU, and BAUS urotrauma guidelines that state that imaging, US or MRI referenced in all guidelines and cavernosography in the EAU version, is optional and potentially helpful in equivocal cases only.²⁻⁴ Unfortunately, several years lacked data on diagnostic imaging in this cohort, therefore we suspect that imaging is not thoroughly or consistently coded in the database. Others have had similar issues obtaining these data from the NIS in this cohort.¹³ Nevertheless, this should be queried in other national databases or registries, given the current guideline recommendations, which could be an avenue of further research.

Our study has several limitations. First, the NIS only captures patients admitted to the hospital. In the aforementioned study of over 8000 US patients presenting to the emergency department with a diagnosis of PF, nearly two-third of the patients were discharged and only a quarter underwent surgical repair.¹² However, the majority of truly clinically suspicious PF will undergo exploration, and therefore it is likely that our sample captured the majority of patients. Second, the administrative nature of the NIS does not allow us to determine the sequence of diagnoses (*i.e.*, whether a PF diagnosis occurred before or after comorbid diagnoses such as erectile dysfunction). Furthermore, we used a cohort of male patients undergoing appendectomy as a control group, given that there are no known racial or socioeconomic predilections for appendicitis. However, unknown and unmeasured factors may have affected our control cohort and therefore biased our comparisons. Finally, this sample is derived from a US-based population and may not be generalizable to other populations. For example, in the majority of cases in the USA, penile fracture occurs during vigorous sexual intercourse; however, “taghaandan,” a common practice in Middle Eastern countries of bending the penis until an audible click is heard, has been reported in up to 60% of cases in one large series.^{16,17} Nevertheless, our study benefits from its large sample size over nearly one decade. The use of a control cohort of surgical

patients allowed us to compare to a similar yet general population. Finally, the implications of our findings are clinically applicable and may help address larger medical issues in this specific cohort of patients.

AUTHOR CONTRIBUTIONS

NCM, ATL, and JM contributed to conceptualization, data curation, analysis, and writing. KEF, KC, and PB contributed to conceptualization, writing, and review. SVE contributed to writing and review. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

COMPETING INTERESTS

All authors declare no competing interests.

REFERENCES

- Ory J, Bailly G. Management of penile fracture. *Can Urol Assoc J* 2019; 13: S72–4.
- Morey AF, Brandes S, Dugi DD, Armstrong JH, Breyer BN, *et al.* Urotrauma: AUA guideline. *J Urol* 2014; 192: 327–35.
- Djakovic N, Plas E, Lynch T, Mor Y, Santucci RA, *et al.* Guidelines on urological trauma. *Update* 2009; 47: 1–15.
- Rees RW, Brown G, Dorkin T, Lucky M, Pearcy R, *et al.* British Association of Urological Surgeons (BAUS) consensus document for the management of male genital emergencies - penile fracture. *BJU Int* 2018; 122: 26–8.
- Sokolakis I, Schubert T, Oelschlaeger M, Krebs M, Gschwend JE, *et al.* The role of magnetic resonance imaging in the diagnosis of penile fracture in real-life emergency settings: comparative analysis with intraoperative findings. *J Urol* 2019; 202: 552–7.
- Gupta N, Goyal P, Sharma K, Bansal I, Gupta S, *et al.* Penile fracture: role of ultrasound. *Transl Androl Urol* 2017; 6: 580–4.
- Wong NC, Dason S, Bansal RK, Davies TO, Braga LH. Can it wait? A systematic review of immediate vs. delayed surgical repair of penile fractures. *J Can Urol Assoc* 2017; 11: 53–60.
- Bozzini G, Albersen M, Otero JR, Margreiter M, Cruz EG, *et al.* Delaying surgical treatment of penile fracture results in poor functional outcomes: results from a large retrospective multicenter European study. *Eur Urol Focus* 2018; 4: 106–10.
- Bolat MS, Özen M, Önem K, Açıkgöz A, Asci R. Effects of penile fracture and its surgical treatment on psychosocial and sexual function. *Int J Impot Res* 2017; 29: 244–9.
- Mirzazadeh M, Fallahkarkan M, Hosseini J. Penile fracture epidemiology, diagnosis and management in Iran: a narrative review. *Transl Androl Urol* 2017; 6: 158–66.
- Tang Z, Yang L, Wei Q, Wang F, Liu LR, *et al.* Management and outcomes of penile fracture: a retrospective analysis of 62 cases with long-term assessment. *Asian J Androl* 2018; 20: 412–3.
- Rodriguez D, Li K, Apoj M, Munarriz R. Epidemiology of penile fractures in United States emergency departments: access to care disparities may lead to suboptimal outcomes. *J Sex Med* 2019; 16: 248–56.
- Pariser JJ, Pearce SM, Patel SG, Bales GT. National patterns of urethral evaluation and risk factors for urethral injury in patients with penile fracture. *Urology* 2015; 86: 181–6.
- Gaither TW, Osterberg EC, Awad MA, Breyer BN. Surgical intervention for penile methamphetamine injections. *Case Rep Urol* 2015; 2015: 467683.
- Kramer AC. Penile fracture seems more likely during sex under stressful situations. *J Sex Med* 2011; 8: 3414–7.
- El Atat R, Sfami M, Benslama MR, Amine D, Ayed M, *et al.* Fracture of the penis: management and long-term results of surgical treatment. Experience in 300 cases. *J Trauma* 2008; 64: 121–5.
- Bastianpillai C, Wang A, Kumaradevan J, Chitale S. Accidental, non-masturbatory, non-intercourse related, self-inflicted penile fracture: case report and review of literature. *Urol Case Rep* 2017; 12: 45–6.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

©The Author(s) (2020)

