Risk Stratification for Erectile Dysfunction After Pelvic Fracture Urethral Injuries

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OBJECTIVE To compare the frequency and severity of erectile dysfunction (ED) among pelvic fracture patients with and without urethral injuries and to identify potential risk factors for ED in the setting of pelvic fracture injury.

MATERIALS AND METHODS A retrospective review was conducted of male patients treated for pelvic fractures with and without urethral injuries at a Level 1 trauma center between 2005 and 2016. The International Index of Erectile Function (IIEF-5) questionnaire was administered to patients by telephone to assess post-injury ED. Additional questions about pre-injury ED, post-injury symptoms, and past medical history were reviewed.

RESULTS Fifty patients (42%, n = 118) responded to the IIEF-5 questionnaire: 29 with pelvic fractures alone and 21 with PFUIs. We observed a numerical increase in frequency of new onset ED in patients with pelvic fracture urethral injuries (PFUIs) (n = 12, 57%) compared with patients with pelvic fractures alone (n = 11, 38%) (P = .3). Patients with PFUIs reported lower IIEF-5 scores (ie worse ED) than patients with pelvic fractures alone (13 versus 18, P = .05). There were no significant differences in potential risk factors between the 2 groups on univariate analyses.

CONCLUSION ED was more severe following PFUI than pelvic fracture alone. We suspect that urethral injury is not the direct cause of ED, but rather a surrogate for extensive pelvic injury and risk for neurovascular injury. A larger prospective analysis is warranted to clarify this hypothesis and to further stratify risk factors for developing ED in pelvic fracture patients with and without urethral injuries. UROLOGY 115: 174–178, 2018. © 2018 Elsevier Inc.

The risk of erectile dysfunction (ED) after pelvic fracture injury is thought to range between 11.6%-24%.[1,2] The pelvis is composed of complex neurovascular structures that are susceptible to insult in the setting of pelvic fracture or disruption. Neurogenic injury is proposed to be the primary source of ED in most pelvic fracture patients.[3,4] Given the proximity of the cavernosal nerve to the bulbomembranous junction, it is thought that pelvic fractures with associated urethral injuries are associated with a higher risk of ED.[1,2,5] King et al found that in a group of 90 patients, 42% of patients with pelvic fracture urethral injuries (PFUIs) had ED compared with 5% of patients with pelvic fractures alone.[6] A recent systematic review by Blaschko et al estimated an ED incidence of 34% after PFUIs, which is also higher than reports for pelvic fractures alone.[7]

ED in the context of PFUIs is understudied, despite affecting a number of healthy, young males each year. Several studies have described general sexual dysfunction; however, few have utilized validated questionnaires such as the International Index of Erectile Function (IIEF-5). Given the relative rarity of PFUIs, we chose to gather preliminary data with a retrospective sample before proceeding with prospective sampling. We aimed to compare the frequency and severity of new onset ED between pelvic fracture patients with and without urethral injuries by retrospectively querying patients about their pre- and post-injury erectile function. Additionally, we aimed to evaluate potential risk factors for ED in these populations, such as traumatic and iatrogenic vascular injuries requiring angioembolization, subsequent urethroplasty, and patient comorbidities. We hypothesized that patients with PFUIs would develop more severe and more frequent ED compared with patients with pelvic fractures alone due to the proximity of the urethra to neurovasculature, which is important for erectile function.

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MATERIALS AND METHODS

Institutional review board approval was obtained to conduct a retrospective review and telephone interview of male patients (n = 118) who were treated for pelvic fractures with and without urethral injuries at a Level 1 trauma center between 2005 and 2016. Patients with pelvic fractures alone were included only if they had a minimum of 5 years of follow-up (n = 72). Due to the infrequency of PFUIs, all patients with PFUI (n = 46) were included without a minimum follow-up requirement. Patient demographics, injury characteristics, and treatments were evaluated. A diagnosis of urethral injury was obtained by retrograde urethrogram or cystoscopy during the initial trauma assessment in patients with a clinical suspicion for urethral injury. Depending on the grade of injury, patients either underwent prompt urinary diversion and drainage by urethral catheter placement, complex urethral catheter placement with cystoscopy, or suprapubic tube placement. Using Organ Injury Scaling, urethral injuries were categorized into incomplete injuries (grade I contusion, grade II stretch injury, and grade III partial disruption) and complete injuries (grade IV and V complete disruption).[8]

All patients were at least 16 years of age at the time of injury and 18 years of age at the time of telephone interview. Each patient was contacted by telephone, and if able and consenting, administered questions from the IIEF-5 (International Index of Erectile Function) Questionnaire. The score from the 5-item questionnaire ranges between 5 and 25 with 22-25, 17-21, 12-16, 8-11, and 5-7 corresponding to no ED, mild ED, mild to moderate ED, moderate ED, and severe ED, respectively.[9] A new diagnosis of ED was defined as a patient having no recollection of ED prior to injury and subsequently having an IIEF-5 score of <22 after injury. An updated past medical history, an assessment of pre-injury sexual function, and a patient report of post-injury glans penis vascular and sensitivity symptoms were also obtained at the time of interview. Glans penis vascular symptom was defined as having a cold glans during an erection. Penile sensitivity was described as either decreased or increased sensitivity of the glans.

A sensitivity analysis was performed to confirm that there were no differences in patient demographics, injury, and treatment characteristics between those who did and did not respond to the telephone questionnaire (data not shown). Analyses of categorical and continuous variables were performed using chi-square test and *t* test, respectively. Univariate and multivariate regression analyses were used to identify risk factors for ED. Statistical significance was set at $P < .05$ and reported P values were two-sided.

RESULTS

Fifty patients (42%, n = 118) responded to the questionnaire and were included in the final analysis: 21 patients (42%) with PFUIs and 29 patients (58%) with pelvic fractures alone (Table 1). Many patients could not be reached despite several attempts predominantly due to out-of-date contact information. Patient demographics were similar between pelvic fracture patients with and without urethral injuries. Mean age at the time of interview was 52 years (±16) and mean time since injury was similar between the 2 groups ($P = .3$). Sixteen patients (32%) reported >1 comorbidity (hypertension, hyperlipidemia, coronary artery disease, diabetes mellitus, or history of tobacco).

At the time of pelvic injury, mean severity scores (29.3 ± 12.3) were similar between the 2 groups; however, patients with PFUI developed concomitant pelvic injuries (bladder, bladder neck, testicular, and rectal) more frequently ($P = .03$). No patients suffered from a spinal cord injury. Pelvic fracture patterns were similar between the 2 groups, except for bilateral pubic rami fractures which developed more frequently in patients with PFUI (29% versus 7%, $P = .04$).

Urethral injuries occurred in both the anterior (33%, n = 7) and posterior (67%, n = 14) urethra. Thirteen patients suffered from incomplete urethral injuries (Grade 1: 0, Grade 2: 2, Grade 3: 11) whereas the remaining 8 patients suffered from complete urethral injuries (Grade 4: 5, Grade 5: 3). Of the 7 patients who developed urethral strictures as sequelae of pelvic injury and required urethroplasty, 6 patients suffered from complete urethral injuries and 1 patient suffered from an incomplete injury. Of the 7 patients who developed anterior urethral injuries, all had concomitant inferior pubic rami fractures or pubis symphysis diastasis. Angiographic embolization for pelvic fractures was performed in 28% (n = 8) and 24% (n = 5) of patients with pelvic fractures and PFUIs, respectively ($P = .8$).

All patients were sexually active before injury with 20% reporting baseline ED and 18% requiring medications to assist with erections (Table 2). Only a numerical difference was identified in the development of new onset ED between patients with PFUIs and pelvic fractures alone (57% versus 38%, $P = .3$). In aggregate, PFUI patients reported lower post-injury IIEF-5 scores (i.e. worse ED) than patients with pelvic fractures alone (13 versus 18, $P = .05$). PFUI patients reported lower scores in the domains of developing erections firm enough for penetration ($P = .03$), maintaining erections ($P = .04$), and maintaining erections to completion of intercourse ($P = .05$). Both groups equally reported decreased confidence with keeping erections ($P = .08$) and frequency of satisfaction of intercourse ($P = .10$). Use of ED medications, penile sensitivity, and glans vascular symptoms after injury were similar between the 2 groups. No risk factors for ED were identified on univariate or multivariate analyses of age, comorbidities, pelvic fracture patterns, urethral injury patterns, urethroplasty status, and pelvic angioembolization status.

COMMENT

ED in the context of traumatic pelvic fractures is understudied. It is important to evaluate ED in pelvic fracture patients because erectile function contributes directly to quality of life and treatments exist.[10,11] Increasing the exposure of orthopedic, trauma, and rehabilitation providers to ED after PFUIs may help to increase opportunities for discussion of sexual function and prompt referrals to urologists when necessary. Since trauma patients are known for exceedingly low compliance with follow up, any ED counseling performed at the time of injury may encourage

Table 1. Patient, injury, and treatment characteristics

	Pelvic Fracture Alone (n = 29)		Pelvic Fracture Urethral Injury (n = 21)		
	N	% / SD	N	% / SD	*P* Value
Patient demographics					
Mean age at time of interview, yrs	53	17	51	14	.7
Age 18-39	7	24	4	19	.9
Age 40-59	8	28	9	43	.4
Age 60-69	10	34	7	33	.9
Age ≥70	4	14	1	5	.6
Mean time since injury, yrs	4.7	2.5	3.9	2.9	.3
>1 comorbidity*	9	31	7	33.3	.9
Mean Injury Severity Score	31	12	29	13	.6
Pelvic fracture injury					
Pubic symphysis diastasis	25	86	15	71	.4
Sacroiliac joint diastasis	21	66	19	81	.2
Sacral fracture	11	38	13	62	.2
Unilateral rami fracture(s)	8	28	7	33	.7
Bilateral rami fractures	2	7	6	29	.04
Urethral injury					
Anterior urethral injury	-	-	7	33	-
Posterior urethral injury	-	-	14	67	-
Incomplete urethral injury	-	-	13	62	-
Complete urethral injury	-	-	8	38	-
Subsequent urethral stricture†	-	-	7	33	-
Concomitant pelvic injuries	3	10	11	52	.03
Bladder injury	2	7	3	14	.7
Bladder neck injury	0	0	2	10	.3
Testicular injury	0	0	3	14	.1
Rectal injury	1	3	2	10	.8
Spinal cord injury	0	0	0	0	-
Treatments					
Urethroplasty	-	-	7	33	-
Pelvic angioembolization	8	28	5	24	.8

SD, standard deviation.
* Hypertension, hyperlipidemia, coronary artery disease, diabetes mellitus, history of tobacco use.
† Stricture as sequela of urethral injury.

Table 2. Erectile function data

	Pelvic Fracture Alone (n = 29)		Pelvic Fracture Urethral Injury (n = 21)		
	N	% / SD	N	% / SD	*P* Value
Pre-injury questions					
Sexually active before injury	29	100	21	100	-
ED affecting sex before injury	6	21	4	19	.9
ED medication before injury	5	17	4	19	.9
Post-injury questions					
New onset ED after injury	11	38	12	57	.3
ED medication use after injury	12	41	10	48	.9
Change in penile sensitivity	6	21	9	43	.2
Glans vascular symptoms	0	0	2	10	.3
Post-injury IIEF-5 questions (Mean)					
Total IIEF-5 score	18	-	13	-	.05
Confidence keeping erection	3.2	1.5	2.4	1.6	.08
Erection firm enough for penetration	3.8	1.5	2.7	1.9	.03
Maintain erection once penetrated	3.8	1.7	2.7	1.9	.04
Maintain erection to completion of intercourse	3.8	1.6	2.8	1.8	.05
Frequency of satisfaction of intercourse	3.7	1.8	2.8	1.8	.1

ED, erectile dysfunction; IIEF-5, International Index of Erectile Function.

patients to maintain follow up and seek treatment in an effort to maintain quality of life.[2,12]

Given the relative rarity of PFUIs, we gathered preliminary, retrospective data of ED in pelvic fracture patients with and without urethral injuries prior to proceeding with prospective sampling. To our knowledge, this is the first contemporary, direct comparison between the 2 cohorts. Prior studies have evaluated ED in each of these cohorts individually and infrequently utilized validated questionnaire, such as the IIEF-5. In our study, PFUI patients only numerically developed new onset ED more frequently than pelvic fracture alone patients (57% vs 38%, $P = .3$); however, in aggregate, patients with PFUI reported lower post-injury IIEF-5 scores (ie worse ED) than patients with pelvic fractures alone (13 vs 18, $P = .05$). Further evaluation with a larger population may better clarify the differences in ED between the 2 patient cohorts.

Traditionally, a sheer-type injury at the prostatomembranous urethra has been proposed as the mechanism for PFUIs since the urethra is intimately attached to the pelvic bone by the puboprostatic ligaments and perineal membrane at this junction. It is now better understood that PFUIs more commonly occur at the bulbomembranous urethra. Andrich et al performed symptomatic, radiologic, endoscopic, and urodynamic evaluations of 20 patients with PFUIs of which 17 (85%) were continent and had intact function of the external urinary sphincter.[13] These findings along with surgical and clinical observations helped lead to the conclusion that most injuries occur at the bulbomembranous urethra. Further analysis suggested that PFUIs may occur due to traction injuries to ligaments supporting the urinary tract rather than a sheer injury.[14] When the pelvic ring is displaced, ligaments supporting the urethra may also be displaced and apply traction to the urethra causing injury. In the case a ligament ruptures, no traction is conferred to the urethra, which may explain how pelvic fractures do not always result in urethral injuries. Direct crush or laceration of the urethra may occur from direct pelvic bone injury but are thought to occur less frequently.

Pelvic fractures may alter erectile function on many levels. Fu et al performed penile Doppler ultrasound in 41 patients with strictures secondary to PFUI and identified 48% with arterial ED, 15% with venous leak, and 37% with nonvascular ED suggestive of neurogenic cause.[15] The cavernosal nerve and branches of the internal pudendal artery facilitate erections and pass near the prostate apex and perineal membrane behind the symphysis pubic before entering the corporal bodies of the penis.[3] The bulbomembranous urethra is the most common location for PFUIs to occur and is in close proximity to the prostate apex and perineal membrane. The intimal association of these structures is presumed to be why PFUIs may be associated with a higher risk of ED.[1,2,5] The close proximity of the cavernosal nerve to the bulbomembranous urethra may explain our finding of worse ED among PFUI patients than patients with pelvic fractures alone.

Certain pelvic fracture injury patterns correlate to concomitant urethral injury and subsequent ED. Koraitim evaluated 90 patients with ED after PFUI using the IIEF-5 questionnaire and identified pubic symphysis diastasis, lateral prostatic displacement, and a long urethral gap as risk factors for ED on multivariate analysis.[16] PFUI patients with bilateral pubic rami fractures were at risk for ED on univariate analysis only. In this present study, patients with PFUI also developed bilateral pubic rami fractures more frequently than patients with unilateral pelvic fractures alone. Of these patients, 5 of 6 patients with PFUI and 0 of 2 patient with pelvic fracture alone developed new onset ED. Basta et al evaluated a cohort of 119 pelvic fracture patients and identified that patients with PFUI presented with higher mean Injury Severity Scores than patients with pelvic fractures alone (24 vs 14).[17] Basta et al identified inward displacement of the medial third of the inferior pubic bone and diastases of the symphysis pubis as risk factors for urethral injury. These findings suggest that patients with PFUI may develop more severe injuries than pelvic fracture patients alone and therefore may be more likely to develop neurovascular injury and ED.

Pelvic fractures can result in extensive retroperitoneal hemorrhage requiring external fixation or selective angioembolization. Selective embolization may fail when an arterial injury in temporary spasm is missed on angiography or when a venous injury is present that will not be treated by selective embolization.[18] In these cases, nonselective bilateral internal iliac artery embolization may be performed. Debate exists whether embolization at the time of initial trauma evaluation may contribute to ED since the arterial supply to the penis originates bilaterally from the internal iliac arteries and branches to the pudendal, common penile, and cavernosal arteries. Angioembolization was not a risk factor for ED in 13 patients from this present study (12 patients treated with gelatin sponge particles and 1 patient treated with coils). Ramirez et al. compared sexual function in 16 patients with pelvic fractures who required bilateral internal iliac artery embolization with gelatin sponge particles to 16 patients with similar pelvic fracture patterns who did not require embolization and 16 patients with severe trauma but no pelvic fractures or pelvic embolization.[18] Sexual function was similar between patients with pelvic fracture who did and did not undergo bilateral internal iliac artery embolization. Sexual function was worse in patients with pelvic fractures compared with patients without pelvic fractures, concluding that pelvic trauma itself was the cause of sexual dysfunction.

Delayed urethroplasty after PFUI has also been suspected to cause ED. Tang et al evaluated IIEF-5 scores in 41 patients who underwent excision and primary anastomosis urethroplasty for PFUIs. Mean IIEF-5 scores decreased after PFUI (pre-injury 23.5 vs post-injury 10.0), but were similar post-injury and post-urethroplasty (post-injury 10.0 vs post-urethroplasty 9.3).[19] Fifteen percent of patients even reported improved erectile function after urethroplasty, perhaps due to the excision of scar and fibrotic tissues that may constrict neurovasculature. Urethroplasty was not a risk factor for ED in 7 patients who required urethroplasty in this present series. Any transient post-urethroplasty ED that may have developed in our cohort had sufficient time to resolve as telephone interviews were administered at a mean of 39 months after urethroplasty.

Limitations of our study include a retrospective review of a small patient cohort and patient recall bias. Pre-injury IIEF-5 scores were not available and therefore telephone interviews were utilized to evaluate patients' subjective recollection of erectile function from several years prior. We were unable to contact many patients due to out-of-date contact information; however, we hypothesize that selection bias was minimal as there were no differences in patient and injury demographics between patients who did and did not participate in this study. Additional confounders may have contributed to ED but were not accounted for, such as undiagnosed psychogenic ED, usage of medication that may affect erectile function, and the natural course of erectile function with age.

CONCLUSION

Patients with PFUI develop more severe erectile dysfunction than patients with pelvic fractures alone. Urethral injury, alone, is unlikely the direct cause of ED in pelvic fracture patients, but rather a surrogate for extensive pelvic injury involving the neurovascular structures central for erectile function. A larger, prospective study will allow for comprehensive risk stratification to better evaluate pre- and post-injury ED.

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