High Rates of Sexual and Urinary Dysfunction After Surgically Treated Displaced Pelvic Ring Injuries

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Abstract

Background Pelvic ring injuries may be associated with genitourinary injury (GUI) and result in urinary or sexual dysfunction.

Questions/purposes We determined (1) incidence of new sexual and urinary dysfunction after surgically treated pelvic ring injuries, (2) association of sexual or urinary dysfunction to fracture type and GUI, and (3) incidence and association between new sexual and urinary dysfunction in male and female patients without GUI.

Methods We retrospectively studied 151 patients by postal questionnaire after pelvic reconstruction. Presence, type, and severity of new sexual dysfunction and urinary dysfunction were related to GUI and type of pelvic fracture using the Young and Burgess classification. Minimum followup was 1 year (median, 5 years; range, 1–12 years).

Results New sexual dysfunction occurred in 61 of 143 (43%) and urinary dysfunction in 61 of 150 (41%)

responding patients. Neither new sexual nor urinary dysfunction was associated with sex or GUI. In patients with no GUI, new sexual dysfunction was associated with chronologic age (odds ratio [OR], 1.04/year; 95% CI, 1.01–1.07) and pelvic fracture type. Lateral compression injury was less likely to result in new sexual or urinary dysfunction compared with AP type (sexual OR, 1.73; 95% CI, 0.67–4.47; urinary OR, 2.97; 95% CI, 1.15–7.66) and vertical shear type (sexual OR, 2.60; 95% CI, 1.02–6.64; urinary OR, 4.6; 95% CI, 1.81–11.73).

Conclusions Our data suggest new sexual and urinary dysfunction occur at relatively high rates after pelvic fracture in patients with or without GUI. We recommend early assessment and referral for specialist treatment.

Level of Evidence Level III, prognostic study. See the Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Introduction

Displaced pelvic ring injuries requiring surgical stabilization are usually the result of high-energy trauma. Associated injuries to neighboring structures both within and outside the pelvic cavity are common [5, 8, 14, 33]. The incidence of associated genitourinary injury (GUI), including bladder disruptions, injury to the bladder neck, and urethral injuries, reportedly ranges from 6.5% to 30% [4, 7, 44]. Bladder ruptures occur in 5% to 16%, urethral injuries in 4% to 14%, and combined bladder and urethral injuries in 0.5% to 2.5% of patients in blunt pelvic trauma [1, 22, 24]. Mainly due to anatomic differences, urethral injuries are much less common in females than males, but rates in females are as high as 4.6% to 6% [4, 32, 42].

Urethral injuries in males may result in strictures, poor stream, infection, and incontinence, as well as erectile dysfunction [21, 22, 24, 44]. Persisting impotence is estimated to occur in approximately 42% of patients after urethral injury [18], but erectile dysfunction is now recognized in patients with no detectable GUI, with an incidence between 5% and 30% in recent studies depending on how dysfunction is assessed [18, 20, 24, 25, 43]. In females, bladder neck and urethral trauma resulting from pelvic fractures can result in urinary incontinence, pelvic organ prolapse, voiding symptoms in up to 43% of cases, and sexual dysfunction in 38% [3, 6, 9, 32]. Urinary symptoms and sexual dysfunction such as dyspareunia, painful orgasms, anorgasmia, and reduced sex drive or pleasure have been reported in the absence of GUI with pelvic fractures [19, 41, 43]. Higher rates of urinary symptoms (33% versus 14%) and dyspareunia (43% versus 25%) were reported in females with residually displaced pelvic fractures than with nondisplaced fractures [11].

Patients sustaining high-energy pelvic ring disruption are usually young and often sexually active. Sexual dysfunction may be associated with depression, lower quality of life, and poorer outcome after injury [12, 43]. Patient-reported outcomes after pelvic trauma are difficult to obtain because patients are often reluctant to talk about urinary incontinence and sexual problems in the clinic. Also, there is limited consensus on the definition of sexual dysfunction, methods and timing of assessment, and treatment [17]. A recent systematic review of sexual function impairment after pelvic fractures, analyzing 1462 patients in 23 studies, reported an overall incidence of sexual dysfunction of 35.9% in men and 39.6% in women [17]. However, the systematic review noted the limited information about the incidence of sexual dysfunction in females with GUI and in both sexes with no GUI [17]. Furthermore, the relationship between urinary and sexual dysfunction in patients after pelvic fracture is poorly understood, particularly in those with no associated GUI, which is important for prognostic and treatment purposes.

We therefore (1) determined the patient-reported incidence of new sexual and urinary dysfunction after surgically treated displaced pelvic ring injuries, (2) identified any association of new sexual and urinary dysfunction to fracture type and GUI for prognostic purposes, and (3) assessed the incidence and any association between new sexual and urinary dysfunction in male and female patients in the absence of GUI.

Patients and Methods

We retrospectively identified all 242 patients who underwent surgical stabilization of a displaced pelvic ring injury

in our pelvic trauma unit between 1994 and 2007. Patients were identified from the pelvic injury database. The inclusion criteria for the study were age greater than 16 years at the time of injury, injury to the pelvic ring (with or without an acetabular injury), surgical treatment (either open reduction and internal fixation, percutaneous fixation, external fixation, or a combination of these), and time longer than 1 year from injury. We excluded 61 patients (eight dead, two with mental incapacity, 51 with no contact details), leaving 181 for the study (Table 1). The minimum followup was 1 year. No patients were recalled specifically for this study; all data were obtained from medical records and questionnaires. The study was approved by the local research ethics committee of our institution.

We sent a postal questionnaire (Appendix 1) comprising 16 questions inquiring of new sexual problems and urologic symptoms experienced since the pelvic injury to 181 patients as part of a wider study of the outcome of surgical treatment of pelvic ring injuries, such as quality-of-life measures. Sexual dysfunction was identified by the response “I have had significant new problems since my injury” to the first sexual function question. Further questions taken from the Sexual Functioning Questionnaire [39] were chosen to identify changes in sexual arousal and sexual desire with men asked about erectile problems, impotence, and ejaculatory problems and women asked about dyspareunia, anorgasmia, and painful orgasms. Patients were asked to subjectively rate the severity of their sexual dysfunction on a five-point semantic differential scale (no problem, very small, small, moderate, or big problem) and a similar question was posed for urinary dysfunction. Urinary dysfunction was identified by any answer other than “no problem” to passing water since injury with further questions related to urinary symptoms of dysuria, frequency, voiding, and continence. No other validation of the questionnaire was performed.

Thirty patients did not respond or refused to participate, leaving 151 patients (83% response) for study (Table 1). The mean age was 40 years (range, 16–76 years) and the median time from injury to followup by questionnaire was 5 years (range, 1–12 years). We had incomplete data on questions of sexual dysfunction from eight patients and urinary dysfunction from one of the 151 patients. Only 130 patients answered both questions subjectively rating the severity of sexual dysfunction and urinary dysfunction. Where incomplete data were received, those patients were excluded from data analysis of the specific questions not answered as indicated in the tables. Definitive surgical treatment of the pelvic ring injury was achieved with open reduction and internal fixation in 127 patients, percutaneous screw fixation in three, external fixation in eight, and combined external fixation with percutaneous screw fixation in 13 patients.

Table 1. Demographics of patients in study

Demographic	Number of patients			p value
	Total	Study group	Excluded or no response	
Questionnaires posted	181	151	30	
Age at time of injury (years)*	38 (16–76)	40 (16–76)	31 (17–65)	0.002 [†]
Sex				0.456
Male	135	111	24	
Female	46	40	6	
Pelvic fracture type				0.919
APC	56	46	10	
LC	66	56	10	
VS	59	49	10	
Pelvic ring injury				0.794
Isolated	142	119	23	
Combined pelvic and acetabular	39	32	7	
Bladder injuries				
Total	7	7	0	0.007
Male	4	4	0	0.042
Female	3	3	0	0.072
Urethral injuries				
Total	13	8	5	0.107
Male	13	8	5	0.115
Female	0	0	0	1.00
GUI bladder and/or urethral injuries				
Total	19	14	5	0.304
Male	16	11	5	0.212
Female	3	3	0	0.072

* Values are expressed as mean, with range in parentheses; [†]Fisher's exact test; Pearson's chi-square test for all other tests; pelvic fracture type = Young and Burgess classification; APC = AP compression; LC = lateral compression; VS = vertical shear; GUI = patients with genitourinary injury (bladder and/or urethral injury; one male patient had both injuries).

We obtained information regarding the type of pelvic fracture and the presence or absence of GUI (diagnosis of urethral or bladder injury) from the pelvic database (Table 1). The pelvic ring injury was classified into three types: AP compression (APC), lateral compression (LC), and vertical shear (VS) using the Young and Burgess classification [8]. Fifteen patients with a combined mechanism injury were classified as VS for analytical purposes because this component was present in all cases. Isolated pelvic injuries were present in 119 (79%) and combined pelvic and acetabular fractures were present in 32 (21%) patients.

Data analysis was under the direction of a medical statistician (PW) and was undertaken using SPSS Version 17.0 (Chicago, IL, USA). An assessment of response bias was undertaken using appropriate standard tests of significance. Fisher's exact test was used to assess any difference in age between responders and nonresponders. We assessed differences in proportions of injury categories, GUIs, and

sex distribution between responders and nonresponders using Pearson's chi-square test. We assessed differences in incidence rates of sexual and urinary dysfunction between pelvic ring injury categories using the Pearson chi-square test. Binary logistic regression was used to assess the multivariate relationship between new sexual dysfunction and urinary dysfunction with the age and sex of the patient, presence or absence of GUI, and type of pelvic ring injury. The extent of the correlation between patient-reported subjective severity of sexual dysfunction and urinary dysfunction was determined using the Goodman gamma statistic.

Results

The incidence of new sexual dysfunction was 43% (61 of 143 responding patients) and the incidence of urinary dysfunction was 41% (61 of 150 responding patients), with

Table 2. Incidence of new sexual dysfunction and urinary dysfunction in relation to sex and associated GUI

Sex/GUI	Number of patients			
	New sexual dysfunction	New urinary dysfunction	Sexual and urinary dysfunction	Total
Males				
Total	52/107* (49%)	47/110 [‡] (43%)	36/106* [‡] (34%)	111
With GUI	7/11 (64%)	6/11 (55%)	5/11 (45%)	11 (10%)
Without GUI	45/96* (47%)	41/99 [‡] (41%)	30/95* [‡] (32%)	100 (90%)
Females				
Total	9/36 [†] (25%)	14/40 (35%)	7/36 [†] (19%)	40
With GUI	1/2 [†] (50%)	2/3 (67%)	1/2 [†] (50%)	3 (7.5%)
Without GUI	8/34 [†] (24%)	12/37 (33%)	6/34 [†] (18%)	37 (92.5%)
Total with GUI	8/13 [†] (62%)	8/14 (57%)	6/13 [†] (46%)	14/151 (9%)
Total without GUI	43/130* [†] (33%)	53/136 [‡] (39%)	36/129* ^{†,‡} (28%)	137/151 (91%)

* Four male patients did not complete this sexual dysfunction question; [†]four female patients did not answer this sexual dysfunction question (one with GUI, three without GUI); [‡]one male patient did not answer this urinary dysfunction question; GUI = genitourinary injury.

Table 3. Components of sexual dysfunction in 107 males

Problem	Number of patients
Any new sexual problems	52 (49%)
Reduced arousal	46 (43%)
Reduced desire	36 (34%)
Ejaculatory problems	30 (28%)
Erectile problems*	21 (20%)
Absolute impotence	2 (2%)

* Including the two cases of absolute impotence.

Table 4. Components of sexual dysfunction in 36 females

Problem	Number of patients
Any new sexual problems	9 (25%)
Reduced arousal	9 (25%)
Reduced desire	7 (19%)
Anorgasmia	3 (8%)
Painful orgasms or dyspareunia	1 (3%)

similar rates in males and females (Table 2). Reduced sexual arousal was the most common complaint in 43% of males (Table 3) and in 25% of females (Table 4). Erectile dysfunction was present in 20% of males and pain in only 3% of females. Four female patients reported no new sexual problems since injury, but two did report increased sexual desire and the other two had increased physical response to sexual stimulation.

We found an association between the type of pelvic injury and the incidence of new sexual dysfunction and urinary dysfunction. Patients sustaining a LC pelvic injury had lower rates of new sexual dysfunction ($p = 0.014$) (Fig. 1) and urinary dysfunction ($p < 0.001$) compared with those patients with APC and VS fracture types

Fig. 1 The association between new sexual dysfunction and pelvic injury type is shown, with a lower incidence rate in LC compared with APC and VS types.

(Table 5). Logistic regression analysis of the data (Table 6) showed there was an association of new sexual dysfunction with the positive predictors of type of pelvic injury and chronologic age of the patient but not with sex or GUI (Table 2). The number of patients with GUI was small, but in 130 patients without GUI, those with VS pelvic injury were 2.6 times more likely to report new sexual problems than those with LC injury. A 1-year increase in age increased the odds of onset of new sexual problems by a factor of 1.04 (odds ratio, 1.04; 95% CI, 1.02–1.07) (Table 6). Similar regression analysis showed there was an association of urinary dysfunction with the positive predictor of type of pelvic injury but not with age, sex, or GUI (Table 7).

In patients with no GUI, the incidence of new sexual dysfunction was 33% overall, affecting 47% of males and 24% of females, and the incidence of urinary dysfunction was 39% overall, affecting 55% of males and 33% of females (Table 2). There was an association between the development of new sexual dysfunction and urinary dysfunction in both male (Table 8) and female patients (Table 9). In those patients reporting new sexual

Table 5. Type of pelvic injury and rates of new sexual and urinary dysfunction

Pelvic injury type (Young and Burgess)	Number of patients				
	Analyzed	APC	LC	VS	All types
All patients	151	46 (31%)	56 (37%)	49 (32%)	151 (100%)
New sexual dysfunction	143*	21/44 (48%)	16/54 (30%)	24/45 (53%)	61 (43%)
New urinary dysfunction	150†	21/46 (46%)	12/55 (22%)	28/49 (57%)	61 (41%)

* Eight patients did not answer this sexual dysfunction question; †one patient did not answer this urinary dysfunction question; APC = AP compression; LC = lateral compression; VS = vertical shear.

Table 6. Logistic regression analysis of potential predictors of new sexual dysfunction

Potential predictor	All patients (n = 143)			Patients with no GUI (n = 130)		
	Odds ratio	95% CI	p value	Odds ratio	95% CI	p value
Age	1.04	1.02–1.07	0.002	1.04	1.02–1.07	0.003
Sex (male)	2.22	0.90–5.49	0.085	2.18	0.85–5.61	0.106
GUI (present)	2.45	0.70–8.65	0.163			
APC type*	1.69	0.69–4.16	0.253	1.73	0.67–4.47	0.256
VS type*	2.48	1.02–6.02	0.045	2.60	1.02–6.64	0.046

* Odds ratio for APC and VS type pelvic injuries compared with LC type; GUI = genitourinary injury; APC = AP compression; VS = vertical shear; LC = lateral compression.

Table 7. Logistic regression analysis of potential predictors of urinary dysfunction

Potential predictor	All patients (n = 150)			Patients with no GUI (n = 136)		
	Odds ratio	95% CI	p value	Odds ratio	95% CI	p value
Age	1.01	0.99–1.04	0.337	1.01	0.99–1.04	0.408
Sex (male)	1.00	0.44–2.30	0.995	1.02	0.43–2.44	0.958
GUI (present)	2.39	0.71–8.06	0.159			
APC type*	3.06	1.24–7.54	0.015	2.97	1.15–7.66	0.025
VS type*	4.78	1.98–11.55	0.001	4.61	1.8–11.73	0.001

* Odds ratio for APC and VS type pelvic injuries compared with LC type; GUI = genitourinary injury; APC = AP compression; VS = vertical shear; LC = lateral compression.

Table 8. Association of new sexual and urinary dysfunction in male patients with no genitourinary injury

Presence of sexual dysfunction	Number of patients		
	Urinary dysfunction	No urinary dysfunction	Total
New sexual dysfunction	30	15	45
No new sexual dysfunction	8	42	50
Total	38	57	95*†

* Four patients did not answer this sexual dysfunction question; †one patient did not answer the urinary dysfunction question; Pearson's chi-square test, $\chi^2 = 25.33$, $p < 0.001$.

dysfunction, 30 of 45 males (67%) and six of eight females (75%) also had urinary dysfunction. We observed a correlation ($\gamma = 0.628$, $p < 0.001$) between subjective severity of sexual and urinary dysfunction reported by 130

Table 9. Association of new sexual and urinary dysfunction in female patients with no genitourinary injury

Presence of sexual dysfunction	Number of patients		
	Urinary dysfunction	No urinary dysfunction	Total
New sexual dysfunction	6	2	8
No new sexual dysfunction	6	20	26
Total	12	22	34*

* Three patients did not answer this sexual dysfunction question; Pearson's chi-square test, $\chi^2 = 7.22$, $p = 0.007$.

patients answering both of these questions. This correlation remained when subdivided into males ($\gamma = 0.602$, $p < 0.001$) and females ($\gamma = 0.712$, $p < 0.001$) and for each type of pelvic injury (APC: $\gamma = 0.456$, $p = 0.008$;

LC: $\gamma = 0.717$, $p < 0.001$; VS: $\gamma = 0.701$, $p < 0.001$). In the 55 patients reporting urinary dysfunction, only seven (13%) had no sexual dysfunction, whereas 33 (60%) rated the severity of their sexual dysfunction as a moderate or big problem. In patients reporting sexual dysfunction, 25 of 52 (48%) males and only one of nine (11%) females reported seeking specialist treatment for the problem.

Discussion

Patients sustaining high-energy pelvic ring disruption may develop urinary or sexual dysfunction resulting from an associated GUI, but these problems can also occur in the absence of GUI [17, 18, 43]. Their true incidence has been difficult to determine due to problems obtaining adequate

Table 10. Summary of literature of sexual dysfunction in males

Study	Number of patients	Age (years)*	Followup (months)*	Sexual dysfunction	Comments
Dhabuwala et al. [15]	26	34 (7–62)	NR (21–NR)	54%	Impotence rate All had urethral rupture and repair
Corriere et al. [13]	50	34 (15–61)	NR (18–NR)	32% 32%	Impotence rate Incomplete erection All had urethral rupture and repair
Mark et al. [26]	92	35 (NR)	48 (12–128)	62%	Impotence rate All had urethral rupture and repair
Shenfeld et al. [38]	25	29 (11–57)	NR (3–36)	72%	Impotence rate All had urethral rupture and referral for repair
Anger et al. [2]	26	40 (20–68)	53 (12–168)	54% 31%	ED Severe ED All had urethral rupture and repair
King [20]	90	28 (< 60)	NR	5% 43%	Impotence rate with no GUI (three of 59) Impotence rate with urethral GUI (13 of 31)
Draijer [16]	36	25 (NR)	24 (NR)	28%	Disturbed sexual function Type B + C Fr types
Malavaud et al. [25]	46	40 (NR)	27 (NR)	30%	-ED (reduced overall satisfaction, erection firmness, or erection confidence)
Ozumba et al. [31]	51	43 (17–85)	38 (24–210)	51% 64%	ED Reduced sexual satisfaction
Wright et al. [43]	192	33 (male + female)	12 (10–14)	21%	Limitation in sexual relationship 8% had incontinence (bowel or bladder)
Metze et al. [28]	77	35 (17–75)	29 (9–NR)	61% 19%	Limitations in sexual function Persistent ED (and temporary ED in 35%)
Collinge et al. [10]	20	48 (19–68)	33 (18–56)	90%	ED with saddle-horn injury 40% had persisting urinary symptoms
Harwood et al. [18]	580	NR	NR	42%	Impotence rate after urethral injury (systematic review of 13 studies)
Harvey-Kelly et al. [17]	497	NR	NR	36%	Sexual dysfunction of varying definitions (systematic review of 12 studies)
Current study	111	41 (16–74)	60 (12–144)	49% 64% 47% 20%	Overall new onset With GUI Without GUI ED

* Values are expressed as mean, with range in parentheses; NR = not reported; ED = erectile dysfunction; GUI = genitourinary injury; Fx type = AO/OTA pelvic fracture type.

followup and the underreporting of these personal issues, as well as the lack of consensus on the definition, use of validated assessment tools, and timing of assessment or treatment of sexual dysfunction [17]. We therefore (1) determined the patient-reported incidence of new sexual and urinary dysfunction after surgically treated displaced pelvic ring injuries, (2) identified any associations of new sexual and urinary dysfunction to fracture type and GUI for prognostic purposes, and (3) assessed the incidence and any association between new sexual and urinary dysfunction in male and female patients with no GUI.

We note the following limitations of our study. First, it was retrospective with a wide range of followup times. A minimum interval of 1 year after injury was used to allow for spontaneous recovery of sexual function [17, 18, 28], but the longer followup period may have included genitourinary problems unrelated to the injury. Second, we used selected questions from the Sexual Functioning Questionnaire [39], validated in the United Kingdom, but did not use a compiled score for severity. We preferred to use a standard five-point semantic differential scale for this purpose to compare patient-perceived severity of sexual

and urinary dysfunction. Third, we had no control subjects without pelvic ring injury because we were assessing the onset of new problems after injury, not preexisting conditions, and it was impractical to study control subjects at an equivalent 5-year median followup after injury. Fourth, we did not evaluate the presence of associated injuries, chronic pelvic pain, or comorbidities that may affect sexual dysfunction.

Our data show both new sexual and urinary dysfunction persist in patients after pelvic ring disruption despite reduction and stabilization of the pelvis with current surgical treatment methods. Overall 43% of patients reported new sexual dysfunction after pelvic injury, whereas 41% had urinary dysfunction, with similar rates in males and females. The most common complaints were of reduced arousal or less sexual desire, but erectile dysfunction was reported in 20% of males and pain in 3% of females. These findings are similar to previous studies (Table 10) reporting rates of impotence of 11% to 30% in males [18, 20, 24, 25, 34], with higher rates in studies considering only patients with urethral rupture [2, 13, 15, 18, 26, 39]. Reported rates of dyspareunia range from 2% [34] to 43% [11] in females

Table 11. Summary of literature of sexual dysfunction in females

Study	Number of patients	Age (years)*	Followup (months)*	Sexual dysfunction	Comments
McCarthy et al. [27]	123	32 (NR)	52 (NR)	39%	Less sexual pleasure
Kiely and Williams [19]	11	NR (NR)	52 (20–84)	46%	Fracture directly affected sexual life
Copeland et al. [11]	123	27 (16–44)	49 (18–85)	31% 43%	New onset dyspareunia Dyspareunia if pelvic fracture displaced (urinary symptoms in 21% overall or 33% if pelvic fracture displaced)
Baessler et al. [3]	24	30 (NR)	29 (12–60)	41%	Dyspareunia, difficulty with sexual intercourse
Black et al. [6]	25	22 (4–67)	88 (19–173)	62%	Eight of 13 sexually active had sexual dysfunction (nine of 21 had moderate or severe urinary dysfunction)
Wright et al. [43]	106	33 (male + female)	12 (10–14)	22%	Any limitation in sexual intercourse 8% had incontinence (urinary or bowel)
Cannada and Barr [9]	71	34 (19–55)	72 (12–81)	49% 38%	Genitourinary complaints Pain on sex intercourse
Harvey-Kelly et al. [17]	368	NR	NR	39.6%	Sexual dysfunction of varying definitions (systematic review of seven studies)
Current study	40	38 (18–76)	60 (12–144)	25% 50% 24%	Overall new onset With GUI Without GUI

* Values are expressed as mean, with range in parentheses; NR = not reported; GUI = genitourinary injury.

after pelvic injury (Table 11). A study of young women after pelvic fracture reported 45% feeling less sexually attractive and 39% experiencing a decrease in sexual pleasure [27]. A systematic review of sexual dysfunction reported a mean incidence of 35.9% (range, 14%–72%) in men and 39.6% (range, 31%–66%) in women [17]. The variation in reported rates may relate to differences in the scope of definition of sexual dysfunction and in the proportion of patients with GUI in previous studies.

Increasing chronologic age and type of pelvic ring injury predicted new sexual dysfunction in patients after pelvic injury. Increasing age in males has been identified as a factor in three previous studies [10, 26, 31]. The Young and Burgess classification, based on the mechanism of injury, was previously reported to predict the presence of associated injuries [14], and for GUI, the highest risk of bladder rupture was in APC3 and of urethral rupture in APC2 and LC2 types [8, 14]. However, our findings were LC type injury was least likely and VS type most likely to result in sexual dysfunction, with similar findings for urinary dysfunction. These findings are supported by a previous German study [28] using the Tile classification [40], which reported higher rates of sexual dysfunction in Type B1 than B2 fractures and in Type C than B2 injuries, as well as other studies showing greater instability associated with more sexual complaints and less recovery [16, 28, 29, 34]. However, there are conflicting reports, with other studies finding no apparent relationship of pelvic fracture type and sexual dysfunction in males [25, 31] or females [3, 9, 11]. In contrast, men with sacroiliac fractures and women with diastasis of the pubis were reportedly at higher risk of sexual dysfunction and incontinence [43], whereas women with residually displaced pubic rami fractures experienced higher rates of urinary complaints and of dyspareunia than those without displacement [11]. Our data suggest neither sex nor presence of GUI was predictive of either sexual (Table 8) or urinary dysfunction (Table 9) despite observing higher incidences in patients with GUI than those with no GUI. However, there was a low number of patients with GUI and low power in the analysis. A systematic review of erectile dysfunction after pelvic injury highlighted the morbidity of GUI and its deleterious effect on sexual function [18]. Previous studies reported high rates of impotence in males after urethral injury [2, 13, 15, 18, 26, 38] or saddle-horn injury [10] (Table 10) and moderate or severe urinary symptoms in 43% of female patients with GUI and sexual dysfunction in 38% [6] (Table 11). Pelvic fracture patterns that may be predictive

of GUI are primarily those associated with disruption of the anterior pubic arch [23, 42], including diastasis of the symphysis pubis [1, 4, 27, 35], displaced inferior pubic ramus fracture [1, 4], bilateral pubic rami fractures [35, 42], combined pubic rami and sacroiliac fractures [5, 23, 35, 42], or sacroiliac joint disruption [5, 22].

In our patients without GUI after pelvic trauma, we found relatively high rates of new sexual dysfunction (47% in males, 24% in females) and urinary dysfunction (41% in males, 33% in females) that have not previously been documented. The incidence of erectile dysfunction in males without GUI has been estimated to be higher than the historical rate of 5% [20], ranging from 11% to 30% [18] and in our study was 20% (Table 10). We identified an association between the presence of urinary and sexual symptoms. If a patient reports persisting urinary symptoms, there is a strong likelihood of associated sexual dysfunction being present. We recommend all patients, not just those with GUI, should be asked specifically about sexual and urinary problems. Use of a validated questionnaire for sexual dysfunction, such as the International Index of Erectile Dysfunction [37] or the Brief Sexual Function Inventory [30, 31] in males and Female Sexual Function Index [36] in females, may facilitate assessing the severity and monitoring change with treatment [17, 25]. The underlying causes of sexual dysfunction after pelvic trauma are related to damage to the autonomic nervous, vascular, or erectile tissues [17, 18, 24, 28, 44]. Delays in assessment and treatment of erectile dysfunction may result in irreversible morphologic and functional changes to the erectile tissue and venoocclusive mechanism with less satisfactory outcome [17, 18, 28, 44]. We found a correlation between patient-reported subjective severity of sexual and urinary dysfunction, supporting the view that psychologic and emotional issues also may be important [17].

The relatively high rate of new sexual and urologic symptoms persisting after pelvic ring reconstruction should alert the attending clinician to the need for early identification and assessment of these problems in patients whether or not there was a GUI. Spontaneous recovery of sexual function is unlikely after 12 to 18 months after injury, and early referral of all affected patients for specialist urologic assessment and treatment is recommended [17, 18, 28, 44].

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Appendix 1

Questionnaire

1a. Pain on passing water (please choose one of the following options)

- I have no pain on passing water ☐
- I have occasional pain on passing water ☐
- I always have pain on passing water ☐

1b. Control when passing water (please choose one of the following options)

- I have had no accidents with passing water (ie, I can control when I urinate) ☐
- I have had occasional accidents with passing water ☐
- I am unable to control when I pass water ☐

1c. Urine flow (please choose one of the following options)

- I can start and maintain a good stream of urine without difficulty ☐
- I have difficulty starting to urinate ☐
- I cannot maintain a good stream of urine ☐

1d. Frequency of passing water (please choose one of the following options)

- During the day, I urinate as often as I used to compared with before my injury ☐
- I pass water more often than normal since the injury ☐
- I pass water less often than normal since the injury ☐

1e. Passing water at night (please choose one of the following options)

- I get up at night as often as I used to (before my injury) to urinate ☐
- I get up significantly more often at night to urinate (since my injury) ☐
- I get up significantly less often at night to urinate (since my injury) ☐

1f. Overall, how much of a problem would you say passing water has been since your injury? (please choose one of the following options)

- No problem at all ☐
- Very small problem ☐
- Small problem ☐
- Moderate problem ☐
- Big problem ☐

1g. Have you had to see a specialist with respect to your bladder/passing water?

Yes ☐ No ☐

If yes, have you been prescribed any medications or had any surgery or investigations (please detail below)?

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2. Sexual function

My sexual function is unchanged when compared with before my injury ☐

I have had significant **new** problems with sexual function since my injury ☐

2a. Over the past month

I have been easily aroused sexually ☐

It has taken longer than usual for me to become sexually aroused ☐

I have been completely unable to become sexually aroused ☐

Although I have been aroused mentally, nothing has happened physically ☐

2b. Sexual function (males only): over the past month

I have had erections (morning erections or erections on awakening)

a. Everyday ☐

b. Approximately three times per week ☐

c. Less than once per week ☐

d. Less than once a fortnight ☐

e. Less than once per month ☐

I do not have erections ☐

I am always able to achieve a full erection if I want to ☐

I feel that my erections are not as full now as they used to be ☐

I am never able to achieve a full erection ☐

I rarely achieve a full erection ☐

Because I cannot achieve a full erection, I am unable to have intercourse ☐

2c. Sexual function (males only):

I ejaculate a long time after I have achieved orgasm ☐

My ejaculation happens too quickly ☐

The amount of fluid that I produce when I ejaculate is less than I used to produce ☐

The amount of fluid that I produce when I ejaculate is more than I used to produce ☐

The color of the fluid that I produce when I ejaculate is different than before ☐

2d. Sexual function (females only): over the past month

Sex has been difficult or painful for me because I do not respond physically ☐

My physical response to sexual stimulation is different now from what it used to be ☐

My physical response to sexual stimulation is better now than it used to be ☐

My physical response to sexual stimulation is worse now than it used to be ☐

2e. Over the past month

- I have not achieved orgasm/ejaculation by any means at all ☐
- I have had orgasms/ejaculations as often as I have wanted ☐
- I have never had an orgasm/ejaculation ☐
- Orgasm/ejaculation has been painful for me ☐
- My orgasm/ejaculation has been different than before ☐
- I have an orgasm/ejaculate every time I have sex/masturbate ☐

2f. How would you rate your level of sexual desire compared with before your injury?

- Unchanged ☐
- Changed significantly. If so, has it... Decreased ☐ Increased ☐

2g. Overall, how much of a problem would you say your sexual function has been since your injury?

- No problem at all ☐
- Very small problem ☐
- Small problem ☐
- Moderate problem ☐
- Big problem ☐

2h. Have you had to see a specialist with respect to your sexual function?

Yes ☐ No ☐

If yes, have you been prescribed any medications or had any surgery or investigations (please detail below)?

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References

- Aihara R, Blansfield JS, Millham FH, LaMorte WW, Hirsch EF. Fracture location influences the likelihood of rectal and lower urinary tract injuries in patients sustaining pelvic fractures. *J Trauma*. 2002;52:205–208.
- Anger JT, Sherman ND, Dielubanza E, Webster GD. Erectile function after posterior urethroplasty for pelvic fracture-urethral distraction defect injuries. *BJU Int*. 2009;104:1126–1129.
- Baessler K, Bircher MD, Stanton SL. Pelvic floor dysfunction in women after pelvic trauma. *Br J Obstet Gynaecol*. 2004;111:499–502.
- Basta AM, Blackmore CC, Wessells H. Predicting urethral injury from pelvic fracture patterns in male patients with blunt trauma. *J Urol*. 2007;177:571–575.
- Bjurlin MA, Fantus RJ, Mellett MM, Goble SM. Genitourinary injuries in pelvic fracture morbidity and mortality using the National Trauma Data Bank. *J Trauma*. 2009;67:1033–1039.
- Black PC, Miller EA, Porter JR, Wessells H. Urethral and bladder neck injury associated with pelvic fracture in 25 female patients. *J Urol*. 2006;175:2140–2144.
- Brandes S, Borrelli J Jr. Pelvic fracture and associated injuries. *World J Surg*. 2001;25:1578–1587.
- Burgess AR, Eastridge BJ, Young JW, Ellison TS, Ellison PS, Poka A, Bathon GH, Brumback RJ. Pelvic ring disruptions: effective classification system and treatment protocols. *J Trauma*. 1990;30:848–856.
- Cannada LK, Barr J. Pelvic fractures in women of childbearing age. *Clin Orthop Relat Res*. 2010;468:1781–1789.
- Collinge CA, Archdeacon MT, LeBus G. Saddle-horn injury of the pelvis: the injury, its outcomes, and associated male sexual dysfunction. *J Bone Joint Surg Am*. 2009;91:1630–1636.
- Copeland CE, Bosse MJ, McCarthy ML, MacKenzie EJ, Guzinski GM, Hash CS, Burgess AR. Effect of trauma and pelvic fracture on female genitourinary, sexual, and reproductive function. *J Orthop Trauma*. 1997;11:73–81.
- Corona G, Ricca V, Bandini E, Mannucci E, Petrone L, Fisher AD, Lotti F, Maggi M. Association between psychiatric symptoms and erectile dysfunction. *J Sex Med*. 2008;5:458–468.
- Corriere JN Jr, Rudy DC, Benson GS. Voiding and erectile function after delayed one-stage repair of posterior urethral disruption in 50 men with a fractured pelvis. *J Trauma*. 1994;37:587–589.
- Delal SA, Burgess AR, Siegel JH, Young JW, Brumback RJ, Poka A, Dunham CM, Gens D, Bathon H. Pelvic fracture in multiple trauma: classification by mechanism is key to pattern of

- organ injury, resuscitative requirements, and outcome. *J Trauma*. 1989;29:981–1002.
15. Dhabuwala CB, Hamid S, Katsikas DM, Pierce JM Jr. Impotence following delayed repair of prostatomembranous urethral disruption. *J Urol*. 1990; 144:677–678.
 16. Draijer F, Eghers HJ, Havemann D. Quality of life after pelvic ring injuries: follow-up results of a prospective study. *Arch Orthop Trauma Surg*. 1997;116:22–26.
 17. Harvey-Kelly KF, Kanakaris NK, Eardley I, Giannoudis PV. Sexual function impairment after high energy pelvic fractures: evidence today. *J Urol*. 2011;185:2027–2034.
 18. Harwood PJ, Grotz M, Eardley J, Giannoudis PV. Erectile dysfunction after fracture of the pelvis. *J Bone Joint Surg Br*. 2005;87:281–290.
 19. Kiely N, Williams N. Sexual dysfunction in women following pelvic fractures with sacro-iliac disruption. *Injury*. 1996;27: 45–46.
 20. King J. Impotence after fractures of the pelvis. *J Bone Joint Surg Am*. 1975;57:1107–1109.
 21. Koraitim MM. Pelvic fracture urethral injuries: the unresolved controversy. *J Urol*. 1999;161:1433–1441.
 22. Koraitim MM, Marzouk ME, Atta MA, Orabi SS. Risk factors and mechanism of urethral injury in pelvic fractures. *Br J Urol*. 1996;77:876–880.
 23. Lowe MA, Mason JT, Luna GK, Maler RV, Copass MK, Berger RE. Risk factors for urethral injuries in men with traumatic pelvic fractures. *J Urol*. 1988;140:506–507.
 24. Machtens S, Gänsslen A, Pohlemann T, Stief CG. Erectile dysfunction in relation to traumatic pelvic injuries or pelvic fractures. *Br J Urol*. 2001;87:441–448.
 25. Malavaud B, Mouzin M, Tricoire JL, Gamé X, Rischmann P, Sarramon JP, Puget J. Evaluation of male sexual function after pelvic trauma by the International Index of Erectile Function. *Urology*. 2000;55:842–846.
 26. Mark SD, Keane TE, Vandermark RM, Webster GD. Impotence following pelvic fracture urethral injury: incidence, aetiology and management. *Br J Urol*. 1975;75:62–64.
 27. McCarthy ML, MacKenzie EJ, Bosse MJ, Copeland CE, Hash CS, Burgess AR. Functional status following orthopedic trauma in young women. *J Trauma*. 1995;39:828–837.
 28. Metze M, Tiemann AH, Josten C. Male sexual dysfunction after pelvic fracture. *J Trauma*. 2007;63:394–401.
 29. Miranda MA, Riemer BL, Butterfield SL, Burke CJ III. Pelvic ring injuries: a long term functional outcome study. *Clin Orthop Relat Res*. 1996;329:152–159.
 30. O’Leary MP, Fowler FJ, Lenderking WR, Barber B, Sagnier PP, Guess HA, Barry MJ. A brief sexual function inventory for urology. *Urology*. 1995;46:697–706.
 31. Ozumba D, Starr AJ, Benedetti GE, Whitlock SN, Frawley WH. Male sexual function after pelvic fracture. *Orthopedics*. 2004;27:313–318.
 32. Perry MO, Husmann DA. Urethral injuries in female subjects following pelvic fractures. *J Urol*. 1992;147:139–143.
 33. Petrisor BA, Bhandari M. Injuries to the pelvic ring: incidence, classification, associated injuries and mortality rates. *Curr Orthop*. 2005;19:327–333.
 34. Pohlemann T, Tscherne H, Baumgartel F, Egbers HJ, Euler E, Maurer F, Fell M, Mayr E, Quirini WW, Schlickewei W, Weinberg A. Pelvic fractures: epidemiology, therapy, and long-term outcome. Overview of the multicenter study of the Pelvis Study Group. *Unfallchirurg*. 1996;99:160–167.
 35. Pokorny M, Pontes JE, Pierce JM. Urological injuries associated with pelvic trauma. *J Urol*. 1979;121:455–457.
 36. Rosen R, Brown C, Heiman J, Leiblum S, Meston C, Shabsigh R, Ferguson D, D’Agostino R Jr. The Female Sexual Function Index (FSFI): a multidimensional self-report instrument for the assessment of female sexual function. *J Sex Marital Ther*. 2000;26:191–208.
 37. Rosen RC, Riley A, Wagner G, Osterloh IH, Kirkpatrick J, Mishra A. The International Index of Erectile Function (IIEF): a multidimensional scale for assessment of erectile dysfunction. *Urology*. 1997;49:822–830.
 38. Shenfeld OZ, Kiselgorf D, Gofrit N, Verstandig AG, Landau EH, Pode D. The incidence and causes of erectile dysfunction after pelvic fractures associated with posterior urethral disruption. *J Urol*. 2003;169:2173–2176.
 39. Smith SM, O’Keane V, Murray R. Sexual dysfunction in patients taking conventional antipsychotic medication. *Br J Psychiatry*. 2002;181:49–55.
 40. Tile M. Pelvic ring injuries: should they be fixed? *J Bone Joint Surg Br*. 1988;70:1–12.
 41. Van den Bosch EW, Van der Kleyn R, Hogervorst M, Van Vugt AB. Functional outcome of internal fixation for pelvic ring fractures. *J Trauma*. 1999;47:365–371.
 42. Watnik NF, Coburn M, Goldberger M. Urologic injuries in pelvic ring disruptions. *Clin Orthop Relat Res*. 1996;329:37–45.
 43. Wright JL, Nathens AB, Rivara FP, MacKenzie EJ, Wessells H. Specific fracture configurations predict sexual and excretory dysfunction in men and women 1 year after pelvic fracture. *J Urol*. 2006;176:1540–1545.
 44. Yerasimides J, Roberts CS. Pelvic fractures and genitourinary injuries. *Curr Orthop*. 2005;19:354–361.