Erectile dysfunction in patients with traumatic urethral strictures treated with anastomotic urethroplasty: a single-factor analysis

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Introduction: *To investigate factors correlated with erectile dysfunction (ED) in patients with traumatic urethral strictures undergoing end-to-end anastomotic urethroplasty (AU).*

Materials and methods: *Between January 2010 and January 2011, 41 patients with urethral strictures resulting from pelvic fracture urethral distraction defects underwent end-to-end AU. The abridged International Index of Erectile Function (IIEF-5) was used to subjectively assess erectile function at admission and 2 weeks postoperatively.*

Results: *Pre- and post-injury IIEF-5 scores differed significantly (23.54 ± 1.45 versus 10.02 ± 3.57; p < 0.0001), but pre and postoperative scores did not (10.02 ± 3.57 versus 9.29 ± 4.14; p = 0.1560). Erectile function declined in all patients after injury and was postoperatively unchanged in 56.10%. Pre- and post-injury scores differed significantly in all ages, stricture location and length groups, but did not change postoperatively. Urethral injury resulted in varying degrees of ED. IIEF-5 scores declined significantly postoperatively in patients with mild/mild–moderate ED (13.86 ± 1.88 versus 11.43 ± 3.37; p = 0.0202), but were unchanged in patients with moderate/severe ED. Vascular ED was predominant (63.41%), and erectile function was better in patients with non-vascular ED than in those with arterial/venous ED (15.50 ± 2.08 versus 11.00 ± 2.35, 8.67 ± 3.21; p = 0.0037, p = 0.0183). IIEF-5 scores decreased significantly in patients with non-vascular ED postoperatively (15.50 ± 2.08 versus 10.00 ± 3.83; p = 0.0132), but were unchanged in patients with arterial/venous ED.*

Conclusion: *Urethral trauma seriously affects erectile function, but subsequent end-to-end AU for urethral strictures has little impact.*

Key Words: abridged International Index of Erectile Function (IIEF-5), end-to-end anastomotic urethroplasty, erectile dysfunction, pelvic fracture urethral distraction defect, urethral stricture

Introduction

Erectile dysfunction (ED) is defined as the inability to achieve or sustain a penile erection sufficient for satisfactory sexual activity. About 3% of ED cases occur secondary to pelvic or perineal trauma.[1] With increasing urbanization, the incidence of such injuries due to vehicular accidents or falls from a height has increased; in cases of simultaneous urethral injury, the incidence of ED is 20%-84%.[2]

Urethral stricture is a common complication following a traumatic injury such as a pelvic fracture urethral distraction defect (PFUDD), which can seriously impact a patient's quality of life due to varying degrees of dysuria or complete obstruction and sexual dysfunction (e.g., ejaculatory dysfunction).[3] To resolve these problems, particularly dysuria, surgery is necessary. However, such surgery may have negative impacts or aggravate the original injuries.

A detailed investigation of the clinical characteristics and pathogenesis of ED in patients with traumatic urethral stricture, and the operative effect on erectile function, could guide diagnosis and treatment and allow the prediction of outcomes. We thus examined these parameters in a sample of patients with urethral strictures resulting from PFUDDs who underwent end-to-end anastomotic urethroplasties.

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Materials and methods

Patients and preoperative examination

With approval from our institution's IRB a total of 41 patients with urethral strictures due to PFUDDs who underwent end-to-end anastomotic urethroplasties in our center between January 2010 and January 2011 were recruited for this study. All patients provided informed consent for inclusion in this study. The patients were aged 17-59 years [mean ± standard deviation (SD), 30.80 ± 9.83 years] and all had ED preoperatively. The development of secondary sexual characteristics and serum concentrations of testosterone, estradiol, prolactin, follicle stimulating hormone, and luteinizing hormone were normal in all patients. Patients with coexisting causes of ED, such as hypertension, diabetes mellitus, heart disease, or chronic liver/kidney disease, and those taking drugs such as psychotropic substances, were excluded from the study.

Urethrography was used preoperatively to determine stricture location (bulbar, bulbomembranous, or membranous urethra) and length (mean ± SD, 2.67 ± 1.27 cm; range, 0.5 cm-6.0 cm). Pharmacopenile duplex ultrasonography (PPUD) was also performed preoperatively to distinguish among the three types of ED (arterial, venous, and non-vascular) using the peak systolic velocity (PSV), end diastolic velocity (EDV), and resistance index (RI) of penile blood vessels; normal values are PSV ≥ 25 cm/s (PSV < 25 cm/s reflects cavernous arterial insufficiency), EDV ≤ 5 cm/s (EDV > 5 cm/s reflects dysfunction of the cavernous venous closure mechanism), and RI ≥ 0.8.[4]

Abridged International Index of Erectile Function (IIEF-5)

Erectile function was assessed using the IIEF-5,[5] which provides a subjective evaluation based on patients' responses to five items covering the following aspects: the ability to achieve penile erection, the effect of stimulation on erection, the continuous state of erection, difficulty maintaining erection, and sexual satisfaction. Each question is scored from 0 (lowest function) to 5 (highest function), with a maximum total score of 25 (no dysfunction). Total IIEF-5 scores were used to categorize patients as follows: < 7, severe ED; 8-11, moderate ED; 12-16, mild-moderate ED; 17-21, mild ED; and > 22, normal function.[5] An improvement (or decline) in erectile function was defined as an increase (or decrease) of at least one ED category. Each patient was asked to complete the IIEF-5 questionnaire at admission time to evaluate erectile function before injury retrospectively and current erectile function, and 2 weeks after surgery to evaluate postoperative erectile function.

Patient group assignment for single-factor analysis

Patients were divided into groups based on age [17-19 years, n = 3 (7.32%); 20-29 years, n = 21 (51.22%); 30-39 years, n = 11 (26.83%); 40-49 years, n = 3 (7.32%); 50-59 years, n = 3 (7.32%)], stricture location [bulbar, n = 11 (26.83%); bulbomembranous, n = 21 (51.22%); membranous, n = 9 (21.95%)], and stricture length [0.1 cm-1.0 cm, n = 4 (9.76%); 1.1 cm-2.0 cm, n = 13 (31.71%); 2.1 cm-3.0 cm, n = 12 (29.27%); 3.1 cm-4.0 cm, n = 6 (14.63%); 4.1 cm-6.0 cm, n = 6 (14.63%)], which were considered as the possible factors related to changes in erectile function. Preoperative erectile function status was thought to be related to postoperative erectile function. The patients were also divided into groups according to degree of preoperative ED [severe, n = 8 (19.51%); moderate, n = 19 (46.34%); mild to moderate, n = 13 (31.71%); mild, n = 1 (2.44%)] and type of preoperative ED [arterial, n = 20 (48.78%); venous, n = 6 (14.63%); non-vascular, n = 15 (36.59%)].

Statistical analysis

SAS 8.1 software (SAS Institute, Cary, NC, USA) was used for statistical analysis and data processing. Data are expressed as mean ± SDs. Differences between pairs of samples were analyzed with t-tests, and differences among multiple samples were examined with analyses of variance. Fisher's exact tests were used to evaluate differences in sample rates among groups. $P < 0.05$ was considered to indicate statistical significance.

Results

Most (95.12%) patients had normal erectile function before injury, and only two had suffered from mild ED before injury. Overall, IIEF-5 scores decreased significantly after injury but did not change markedly following surgery, Table 1. Erectile function declined to varying degrees in all patients (100%) after injury;

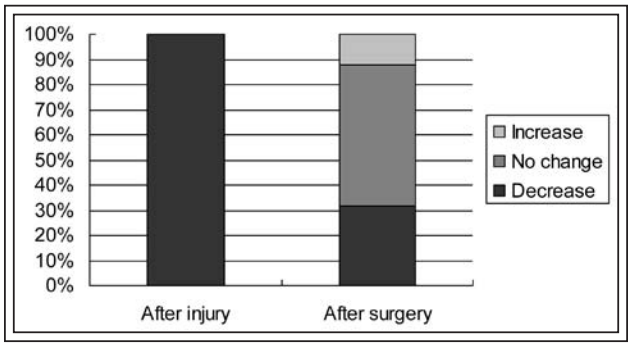

Figure 1. Changes in erectile function after injury and surgery in 41 patients with urethral strictures.

TABLE 1. **International Index of Erectile Function (IIEF-5) scores of patients at three time points**

	Before injury	After injury (before surgery)	After surgery	P_1	P_2
IIEF-5 score	23.54 ± 1.45	10.02 ± 3.57	9.29 ± 4.14	< 0.0001	0.1560

P_1 = pre- versus post-injury IIEF-5 scores; P_2 = pre versus postoperative IIEF-5 scores

TABLE 2. **International Index of Erectile Function (IIEF-5) scores of patients grouped by age, stricture location, and stricture length**

Factor	Group	Before injury	After injury (before surgery)	After surgery	P_1	P_2
Age (years)	17-19	21.67 ± 2.52	11.00 ± 5.29	9.33 ± 4.93	0.0236	0.5254
	20-29	23.81 ± 1.25	9.29 ± 3.68	9.10 ± 4.49	< 0.0001	0.8045
	30-39	23.73 ± 1.49	11.09 ± 3.59	9.27 ± 4.36	< 0.0001	0.1145
	40-49	23.33 ± 1.15	9.33 ± 2.31	9.67 ± 2.08	0.0198	0.4226
	50-59	23.00 ± 1.00	11.00 ± 2.65	10.33 ± 3.79	0.0069	0.4226
Location	BU	23.73 ± 1.10	8.82 ± 4.33	8.45 ± 5.01	< 0.0001	0.5527
	BMU	23.33 ± 1.74	10.29 ± 2.81	9.24 ± 3.83	< 0.0001	0.2757
	MU	23.78 ± 1.09	10.89 ± 4.20	10.44 ± 3.88	< 0.0001	0.2721
Length (cm)	0.1-1.0	24.25 ± 0.96	11.00 ± 5.10	10.50 ± 5.26	0.0098	0.7688
	1.1-2.0	23.23 ± 1.69	10.31 ± 3.43	10.23 ± 3.63	< 0.0001	0.8990
	2.1-3.0	23.42 ± 1.56	10.33 ± 3.17	9.67 ± 4.14	< 0.0001	0.4930
	3.1-4.0	23.33 ± 1.03	8.17 ± 4.40	7.83 ± 5.49	0.0006	0.8560
	4.1-6.0	24.17 ± 1.33	10.00 ± 3.41	7.17 ± 2.99	0.0003	0.1719

P_1 = pre- versus post-injury IIEF-5 scores; P_2 = pre versus postoperative IIEF-5 scores; BU = bulbar urethra; BMU = bulbomembranous urethra; MU = membranous urethra

TABLE 3. **Postoperative changes in erectile function of patients grouped by age, stricture location, and stricture length**

Factor	Group	Increase		No change		Decrease		P
		n	%	n	%	n	%	
Age (years)	17-19	0	0	2	66.67	1	33.33	0.4704
	20-29	5	23.81	10	47.62	6	28.57	
	30-39	0	0	6	54.55	5	45.45	
	40-49	0	0	3	100.00	0	0	
	50-59	0	0	2	66.67	1	33.33	
Location	BU	1	9.09	8	72.73	2	18.18	0.2031
	BMU	4	19.05	8	38.09	9	42.86	
	MU	0	0	7	77.78	2	22.22	
Length (cm)	0.1-1.0	1	25.00	1	25.00	2	50.00	0.0512
	1.1-2.0	1	7.69	11	84.62	1	7.69	
	2.1-3.0	1	8.33	8	66.67	3	25.00	
	3.1-4.0	1	16.67	2	33.33	3	50.00	
	4.1-6.0	1	16.67	1	16.67	4	66.66	

BU = bulbar urethra; BMU = bulbomembranous urethra; MU = membranous urethra

TABLE 4. **International Index of Erectile Function (IIEF-5) scores of patients with different degrees and types of erectile dysfunction after injury**

Preoperative erectile dysfunction	Group	Before surgery	After surgery	P
Degree	Mild/mild-moderate[a]	13.86 ± 1.88	11.43 ± 3.37	0.0202
	Moderate	9.26 ± 1.10	9.74 ± 3.71	0.5317
	Severe	5.13 ± 2.23	4.50 ± 2.33	0.1803
Type	Arterial	11.00 ± 2.35	11.15 ± 3.72	0.8688
	Venous	8.67 ± 3.21	9.00 ± 6.24	0.8845
	Non-vascular	15.50 ± 2.08	10.00 ± 3.83	0.0132

[a]Only one patient had mild erectile dysfunction preoperatively, so patients with mild and mild–moderate erectile dysfunction were grouped together

pre and postoperative erectile function did not differ significantly in most patients, but postoperative improvement or decline in erectile function was noted in some patients, Figure 1.

Pre-injury and preoperative IIEF-5 scores did not differ significantly among age groups (p = 0.3419 and p = 0.7132, respectively), stricture location groups (p = 0.8633 and p = 0.3983, respectively), or stricture length groups (p = 0.4874 and p = 0.7385, respectively). In each age, stricture location, or stricture length group, IIEF-5 scores decreased significantly after injury but did not change significantly after surgery, Table 2. The proportion of patients with each of the three categories of postoperative changes in erectile function did not differ significantly among age, stricture location, or stricture length groups, Table 3. Postoperative IIEF-5 scores did not differ significantly among stricture length groups (p = 0.4762), but tended to be lower with increasing stricture length, Table 2. In addition, the proportion of patients whose erectile function decreased postoperatively increased with stricture length, excepting the first group, Table 3.

The IIEF-5 scores of patients with mild and mild-moderate ED decreased significantly postoperatively (versus preoperatively), whereas the pre and postoperative scores of patients with moderate and severe ED were similar, Table 4.

Preoperative IIEF-5 scores of patients with non-vascular ED were significantly higher than those of patients with arterial or venous ED (p = 0.0037 and p = 0.0183, respectively), but the scores of patients with arterial and venous ED did not differ significantly (p = 0.1652). IIEF-5 scores decreased significantly in the non-vascular ED group following surgery, whereas the scores of the other two groups did not change postoperatively, Table 4. Postoperative IIEF-5 scores did not differ significantly among these three groups (p = 0.1755).

Discussion

The significant declines we observed in all patients' IIEF-5 scores after injury confirmed that urethral injury seriously impacted patients' erectile function. Similarly, Anger et al[6] found that 54% of patients with a PFUDD injury had ED, and about 30% had severe ED. The neurovascular damage to the cavernous nerves that occurs at the time of urethral distraction injury is regarded as the primary cause of ED in patients with PFUDD injuries.

Previous studies of post-trauma urethral stricture surgery have focused primarily on the recovery of urination function. With continual improvements in surgical technologies and the rapid updating of repair materials, the success rate of urethral repair has markedly increased.[7,8] Thus, an increasing number of studies have focused on the relationship between such surgery and sexual function by examining the effects of several factors (e.g., age, stricture location and length) on postoperative erectile function.

The negative impact of urethral injury on erectile function is visible, but end-to-end anastomotic urethroplasty does not appear to have further negative effects. Berger et al[9] found no significant difference in the incidence of ED (~17%) before and after posterior urethral reconstructive surgery; similarly, Santucci et al[10] reported a ~1% incidence of new ED in 168 patients after bulbar urethral anastomosis. However, given the significant impact of urethral trauma on erectile function in the 41 patients in our study (erectile function declined in all patients after injury and no patient had normal preoperative erectile function), the measurable impact of surgery on erectile function might have been reduced to some degree. Patients with normal preoperative erectile function are more likely than those with ED to perceive a postoperative

decline in erectile function.[11] Thus, more cases should be analyzed to provide more comprehensive clinical data and improve the accuracy of the results.

Age significantly impacts sexual function. In most countries and regions of the world, the incidence of ED is highest (20%-40%) in men aged 60-69 years and increases significantly after 65 years of age. Mark et al[12] showed that older patients were at greater risk for impotence following PFUDD ($p \leq 0.013$). Anger et al[13] reported that the incidence of ED after urethral surgery was higher in a group of men with a mean age of 47 years than in that with a mean age of 36.8 years. Erickson et al[3] demonstrated that urethral surgery had the greatest impact on erectile function in patients aged 50-59 years, whereas erectile function did not change significantly after surgery in younger (≤ 49 years) patients. The increased incidence of ED in older patients is due to the difficulty of tissue repair and collateral circulation formation in these patients after injury. In our study, however, age was not related to post-injury or postoperative changes in erectile function. This inconsistency in findings may be attributed to the age structure of our sample; our patients were relatively young (17-59 years) and only three were over 50 years of age. Erickson et al[3] and Singh et al[14] found that ejaculation function improved after surgery. Further studies are needed to more comprehensively examine the correlation between age and sexual function.

Our study found no evidence that stricture location affected post-injury erectile function; as in other studies, we also found that stricture location was not related to postoperative changes in erectile function. Anger et al[13] performed four types of reconstructive surgeries on 25 patients with bulbar urethral strictures, and found that these surgeries had no significant effect on erectile function. Shenfeld et al[2] also found that membranous urethral surgery had little impact on erectile function. Kesseler et al[15] reported long term follow up results of end-to-end anastomotic urethroplasty for bulbar (33%), bulbomembranous (10%), and membranous (58%) urethral strictures; sexual function declined in only 2/40 patients.

Urethral stricture length can reflect the severity of urethral injury and is an important factor in pre and postoperative erectile function. In 52 patients with urethral injury following pelvic fracture, Gao et al[16] found a significant difference in stricture length between those with ED (n = 35; 3.8 cm ± 1.1 cm) and those without ED (n = 17; 2.3 cm ± 1.3 cm). Coursey et al[17] reported that patients with long urethral strictures had a higher incidence of ED after repair. We found that erectile function decreased with increasing stricture length, and patients with longer strictures were more likely to have decreased erectile function postoperatively. Frequent urethral dilatations and instrumentation, long term catheterization, and repeated urethritis cause serious damage to the urethra and surrounding tissues, leading to scarring fibrosis and the emergence of long-segment urethral strictures; during surgical repair, the scar tissue requires extensive resecting and the urethra must be mobilized more widely, which can increase the risk of damaging vessels and nerves, thereby contributing to sexual dysfunction. Therefore, urethral stricture length is closely related to changes in erectile function.

All patients in our sample had varying degrees of ED preoperatively due to urethral trauma. Erectile function declined significantly in patients with mild and mild-moderate ED postoperatively, but did not change in patients with moderate or severe ED after surgery. These findings indicate that patients with milder ED, and thus relatively less neurovascular damage, were more likely to be affected by surgery. No other study has produced this specific finding. Patients with normal or nearly normal erectile function should be fully informed of this risk preoperatively. However, many studies have demonstrated that sexual function may improve to some extent over time after injury or surgery, as the patient's physical and mental conditions improve. Aubert et al[18] analyzed 16 cases of impotence associated with pelvic fracture and urethral rupture, and reported that 10 (62.5%) patients spontaneously regained satisfactory erections. Mundy[19] reported that 53% of patients who received urethral anastomosis had ED within 3 months after surgery, but that this rate declined to 5% at 1 year postoperatively. Coursey et al[17] confirmed that erectile function, including erectile length, penile angle, and many other factors, improved gradually over time.

Preoperative PPUD demonstrated that ED was caused by serious injury in our sample, and that vascular ED was predominant (63.41%). Asci et al[20] also found that ED following pelvic fractures was mainly due to penile vascular dysfunction. Non-vascular ED may be due to neurological, psychological, or unexplained causes. We found significantly better post-injury erectile function in patients with non-vascular ED than in those with vascular ED, indicating the important role of vascular factors in the pathogenesis of ED after urethral injury. We also found that surgery had a significant impact on erectile function in patients with non-vascular ED, but not in those with vascular ED. This outcome was probably due to vessel damage during surgery in patients with non-vascular ED, which further aggravated ED. Patients with arterial and venous ED were less affected by surgery because the vessels had been damaged to varying degrees at the time of injury.

Conclusion

Urethral trauma resulting from high-energy pelvic fracture seriously affects erectile function, leading predominantly to vascular ED. Subsequent end-to-end anastomotic urethroplasty for a urethral stricture, however, has little effect on erectile function. Factors such as stricture length and preoperative sexual function status influence patients' erectile function after surgery, whereas other factors such as age and stricture location are not specifically related to postoperative changes in erectile function. □

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