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Predictors for success of internal urethrotomy in patients with urethral contracture following perineal repair of pelvic fracture urethral injuries

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ABSTRACT

Introduction: Internal urethrotomy (IU) in patients with urethral contracture following perineal repair of pelvic fracture urethral injuries (PRPFUI) is troublesome. We evaluated the clinical factors affecting the surgical outcome of IU for urethral contracture after PRPFUI.

Materials and methods: We retrospectively reviewed the records of 35 patients who underwent IU for urethral contracture after PRPFUI between March 2004 and June 2013. Ages of patients ranged from 18 to 50, and their follow-up duration was more than 1 year after IU. The urethral contracture was confirmed by retrograde urethrogram or cysto-urethroscopy. Success was defined as greater than 15 mL/s of peak urinary flow rate at 1 year after IU without any clinical evidence of urethral contracture. Success rates were investigated according to the number of IU. Age, body mass index, urethral defect length before PRPFUI, time interval between the original urethral injury and the PRPFUI or between a previous operation and the PRPFUI, time interval between the PRPFUI and the urethral contracture, number of PRPFUI performed, and the type of urethral lengthening procedure were compared between patients with and without success according to the number of IU.

Results: Among the 35 patients, the overall success rate of IU was 37% (13/35) during the mean follow-up period of 53 months (range: 17–148 months). There were 8 and 5 patients with success in first and second IU, respectively. However, there was no success after third IU. Urethral defect length before PRPFUI was significantly shorter in patients with success who underwent first and second IU ($p < 0.05$). There were significant differences of success between patients with and without previous repeated failures of PRPFUI in first and second IU ($p < 0.05$).

Conclusions: Short urethral defect length and no previous surgical failures before PRPFUI are good prognostic factors for IU following PRPFUI. Only one or two IUs will be helpful in patients with urethral contracture following PRPFUI.

Introduction

Pelvic fracture urethral injuries are the result of blunt pelvic trauma and its incidence was reported ranging between 1.6% and 25% [1–3]. These injuries usually cause an avulsion of bulbomembranous junction where it is liable to rupture [4]. The ideal treatment for pelvic fracture urethral injuries consists of meticulous removal of fibrotic tissues on the urethral defect and tension-free end-to-end anastomosis [5–7]. Although surgical methods to increase success rate are well known such as a golden triad for the posterior urethroplasty that is composed of complete excision of scarred tissue, a lateral fixation of healthy urethral end mucosa, and the creation of a tension-free anastomosis, repair of pelvic fracture urethral injuries is still challenging [6,7]. Moreover, any urethral contracture following failed repair of pelvic fracture urethral injuries can be a big concern not only to patients, but also to surgeons.

Internal urethrotomy (IU) refers to any procedure that opens the stricture by incising it transurethrally. Although the risk of urethral stricture recurrence was likely to be high, it is commonly performed for urethral strictures because it is simple and less invasive compared with an open urethroplasty [8,9]. However, there are very limited data on the surgical outcome of IU in patients with urethral contracture, unlike urethral stricture, which is an obliterative process in the posterior urethra caused by urethral distraction injury such as pelvic fracture urethral injuries. In addition, to our best knowledge, there is no paper investigating the clinical factor affecting the surgical outcome of IU for urethral contracture

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Table 1
Success rates according to the number of internal urethrotomy.

Internal urethrotomy	Number of success	Number of failure without further IU		Number of failure with further IU		Exact 95% CI for the success rate (%)
		Not wanting further IU	Follow-up loss		Success rate (%)	
1st	8	1	1	25	23 (8/35)	10–40
2nd	5	5	1	14	20 (5/25)	7–41
3rd	0	5	1	8	0 (0/14)	0–23
4th	0	1	0	7	0 (0/8)	0–37
5th	0	0	0	7	0 (0/7)	0–41
6th	0	2	0	5	0 (0/7)	0–41
7th	0	4	1	0	0 (0/5)	0–52

IU, internal urethrotomy; CI, confidence interval.

following perineal repair of pelvic fracture urethral injuries (PRPFUI). Therefore, we evaluated relevant clinical factors to determine predictors of successful IU for urethral contracture after PRPFUI.

Materials and methods

Patients

After acquiring approval from the institutional review board at CHA Bundang Medical Center, we reviewed the medical records of 226 patients who underwent posterior urethral reconstruction for pelvic fracture urethral distraction defects between March 2004 and June 2013. The need for written informed consent was waived because this study was conducted by retrospective chart review. We identified 39 patients aged ≥18 years who underwent IU for urethral contracture following PRPFUI. Patients with neurogenic issues that might affect voiding function were excluded. Patients who conducted urethral dilation after IU were also excluded.

Inclusion criteria were (1) age range from 18 to 50, (2) short and passable urethral contracture after PRPFUI (less than 10 mm on retrograde urethrogram), and (3) more than 1 year of follow-up after IU. Thirty five patients met the inclusion criteria.

Preoperative and operative procedures

The length and patency of the urethral contracture were assessed by retrograde urethrography. The procedure was performed with each patients placed in a lithotomy position and under spinal anesthesia. A cold knife urethrotome was used to incise the urethral contracture. An incision was made at the 12-o'clock position along its entire length and depth.

Definition of internal urethrotomy success

A successful outcome was defined as meeting the following criteria: (1) peak urinary flow rate greater than 15 mL/s at 12 months postoperatively, (2) no evidence of urethral contracture on retrograde urethrogram or cysto-urethroscopy postoperatively, and (3) no obstructive urinary symptoms for the follow-up period. The outcome was regarded as a success when the result of the final IU met the success criteria, even if the result of a previous IU was a failure. Patients were divided into one of two groups, success or failure. Success rates were investigated according to the number of IU.

Follow-up

The urethral catheter was removed three days postoperatively. Follow-up was scheduled at 1st, 3rd, 6th, 9th, 12th, 18th, 24th month, and every 12 months thereafter. Uroflowmetry and post-void bladder scanning were performed regularly on each follow-up visit and also performed as needed when patients complained of any obstructive symptom (hesitancy, abdominal straining, sense of incomplete sensing, decreased urinary stream). Retrograde urethrography was performed when the maximum flow rate was less

Table 2
Comparison between patients with success and failure who underwent first internal urethrotomy for urethral contractures following perineal repair of pelvic fracture urethral injuries [Data are presented as the mean (standard deviation)].

Characteristics	Total	Success	Failure	P Value*
Number of patients	35	8	27	
Age (years)	37 (9)	33 (10)	38 (9)	0.187[a]
BMI (kg/m^2)	23.7 (3.1)	23.5 (3.4)	23.7 (3.0)	0.827[a]
Urethral defect length before PRPFUI(cm)[c]	3.0 (1.4)	2.1 (0.8)	3.3 (1.5)	0.031[a]
Time interval (month)[d]	10.7 (6.5)	6.4 (6.1)	12.0 (6.1)	0.028[a]
Time to urethral contracture (month)[e]	5.9 (5.7)	8.1 (7.0)	5.2 (5.2)	0.210[a]
Number of PRPFUI performed (only once/more than once)	17/18	7/1	10/17	0.036[b]
Lengthening procedure				0.842[b]
UM	2	1	1	
UM + CS	9	2	7	
UM + CS + IP	5	1	4	
UM + CS + IP + UR	19	4	15	

SD = Standard deviation; UM = urethral mobilization; CS = corporal separation; IP = inferior pubectomy; UR = urethral rerouting.
* $p < 0.05$ was considered statistically significant.
[a] *t*-test.
[b] Fisher's exact test.
[c] Perineal repair of pelvic fracture urethral injuries.
[d] Time interval between the original urethral injury and the PRPFUI or between a previous operation and the PRPFUI.
[e] Time interval between the PRPFUI and the urethral contracture.

than 15 mL/s. Cysto-urethroscopy was routinely performed on 12 months after IU to confirm wide open urethra.

Data analysis

The following parameters were evaluated as potential influencing factors of surgical outcome of IU: age; body mass index (BMI); the time interval between the original urethral injury and the PRPFUI, or between a previous operation and the later PRPFUI; the initial length of urethral defect before PRPFUI; the time interval between the PRPFUI and the first urethral contracture before IU; the number of PRPFUI performed before IU (only once vs. more than once); the type of urethral lengthening procedures at the time of PRPFUI. All the predictive factors were compared between patients with success and failure using the *t*-test and Fisher's exact test according to the number of IU. Statistical analyses were performed using SPSS 19.0 (IBM Corp, Armonk, NY). Data are presented as the mean (standard deviation). A p value of <0.05 was considered statistically significant.

Results

The mean age of the 35 patients was 37 years (range: 20–49 years). The causes of urethral injury were 24 motor vehicle accidents (69%, 24/35) and 11 falling down/crash injuries (31%, 11/35). Eighteen of the 35 patients (51%) had a previous history of failed PRPFUI more than once. Success was achieved in 13 of the 35 patients (overall success rate, 37%), and the mean follow-up period was 53 months (range: 17–148 months).

Table 1 shows success rates according to the number of IU. As the number of IU increased, the success rate decreased. The success rate of the first IU was 23% (8/35). Among the 27 patients with failure after first IU, two patients didn't undergo further IU. One patient gave up a further IU and the other got lost to follow-up. In the remaining 25 patients, the success rate of the second IU was 20% (5/25). Among the 20 patients with failure after second IU, six patients didn't undergo further IU. Five patients gave up a further IU and one patient got lost to follow-up. The remaining 14 patients underwent third IU. However, no successful outcome was observed in any patients with three or more IU procedures.

Clinical factors associated with PRPFUI were compared between patients with success and failure who underwent first IU (Table 2). The initial urethral defect length before PRPFUI was significantly shorter in patients with successful outcomes than in patients with unsuccessful outcomes ($p = 0.031$). Fig. 1(**A**) shows the dot plot of the initial urethral defect length before PRPFUI in patients who underwent first IU. Time interval between the original urethral injury and the PRPFUI or between a previous operation and the PRPFUI was also significantly shorter in patients with successful outcomes than in patients with unsuccessful outcomes ($p = 0.028$). There were significant differences between the two outcome groups in terms of the number of PRPFUI performed (only once vs. more than once, $p = 0.036$). The two groups did not differ in terms of age, BMI, time interval between the PRPFUI and the urethral contracture, the type of urethral lengthening procedure.

Clinical factors associated with PRPFUI were also compared between patients with success and failure who underwent second IU (Table 3). The initial urethral defect length before PRPFUI was significantly shorter in patients with successful outcomes than in patients with unsuccessful outcomes ($p = 0.003$). Fig. 1(**B**) shows the dot plot of the initial urethral defect length before PRPFUI in patients who underwent second IU. There were significant differences between the two outcome groups in terms of the number of PRPFUI performed (only once vs. more than once, $p = 0.010$). There were also significant differences between the two outcome groups in terms of the type of urethral lengthening procedure ($p = 0.005$). The two groups did not differ in terms of age, BMI, time interval between the original urethral injury and the PRPFUI or between a previous operation and the PRPFUI, time interval between the PRPFUI and the urethral contracture.

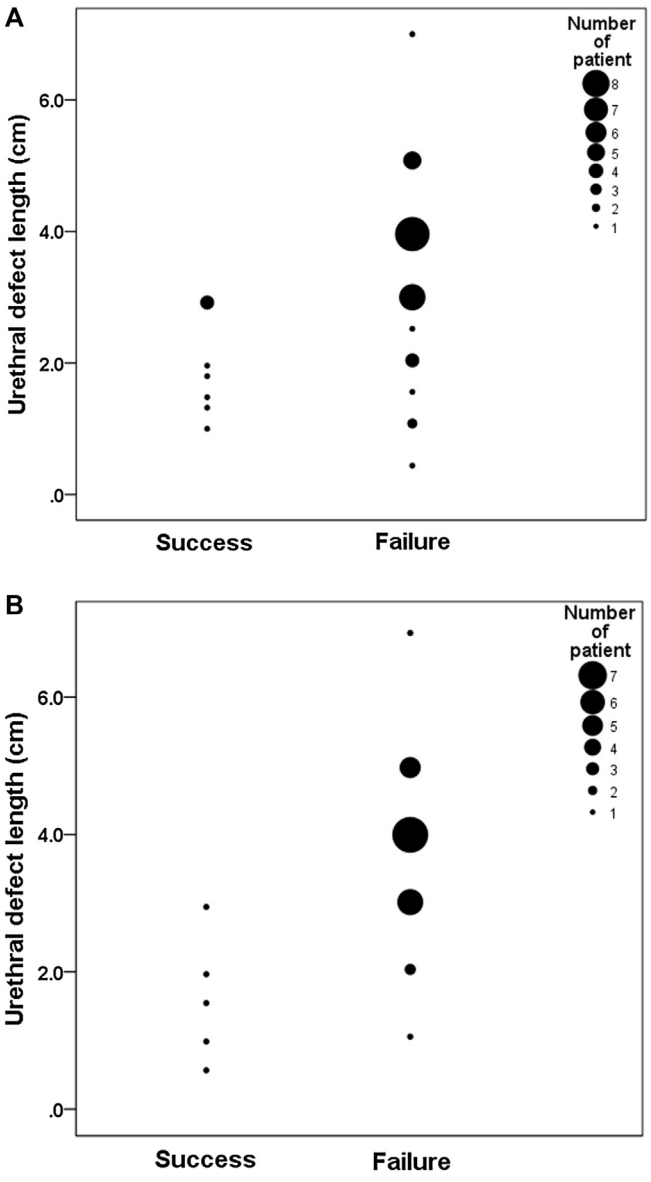

Fig. 1. (**A**) Distribution of the initial urethral defect length between patients with success and failure who underwent first internal urethrotomy for urethral contractures following perineal repair of pelvic fracture urethral injuries. (**B**) Distribution of the initial urethral defect length between patients with success and failure who underwent second internal urethrotomy for urethral contractures following perineal repair of pelvic fracture urethral injuries. The size of each shaded circle indicates the number of patients.

The comparison results of first and second IU showed that the initial urethral defect length before PRPFUI and the number of PRPFUI performed were significantly influencing factor for success of IU.

Discussion

Studies on the outcome of IU for urethral contracture after PRPFUI are very rare. Although Helmy and co-workers reported

Table 3
Comparison between patients with success and failure who underwent second internal urethrotomy for urethral contractures following perineal repair of pelvic fracture urethral injuries [Data are presented as the mean (standard deviation)].

Characteristics	Total	Success	Failure	P Value*
Number of patients	25	5	20	
Age (years)	38 (9)	37 (8)	38 (10)	0.975[a]
BMI (kg/m^2)	23.8 (3.2)	23.4 (4.0)	23.8 (3.0)	0.804[a]
Urethral defect length before PRPFUI(cm)[c]	3.3 (1.5)	1.6 (1.0)	3.8 (1.3)	0.003[a]
Time interval (month)[d]	12.1 (5.9)	8.4 (3.4)	13.1 (6.1)	0.120[a]
Time to urethral contracture (month)[e]	4.7 (4.3)	5.0 (5.8)	4.7 (4.0)	0.874[a]
Number of PRPFUI performed (only once/more than once)	10/15	5/0	5/15	0.010[b]
Lengthening procedure				0.005[b]
UM	1	0	1	
UM + CS	6	4	2	
UM + CS + IP	4	1	3	
UM + CS + IP + UR	14	0	14	

SD = Standard deviation; UM = urethral mobilization; CS = corporal separation; IP = inferior pubectomy; UR = urethral rerouting.
* $p < 0.05$ was considered statistically significant.
[a] *t*-test.
[b] Fisher's exact test.
[c] Perineal repair of pelvic fracture urethral injuries.
[d] Time interval between the original urethral injury and the PRPFUI or between a previous operation and the PRPFUI.
[e] Time interval between the PRPFUI and the urethral contracture.

that IU was successful in 20 of 22 (90%) children who underwent IU for urethral stricture after perineal anastomotic urethroplasty for post-traumatic posterior urethral strictures, however in cannot be applicable to adults [10]. Al Rifaei and Al Rifaei reported that they performed IU in 3 patients with short and passable strictures out of 25 patients with postoperative obstruction after urethroplasty, and the outcome of all the three patients was good [11]. Most researchers believe that IU should be done in short, passable urethral strictures. Other than that, no predictive factor affecting the result of IU for treatment of urethral contracture following PRPFUI has been evaluated.

In our study, previous history of two or more PRPFUI was a significant predictor of IU failure for urethral contracture. This finding is somewhat expected based on previous studies, which have shown that a previous failed urethroplasty significantly decreases the success of subsequent anastomotic urethroplasty [12,13]. A previously failed urethroplasty might be associated with inadequate urethral mobilization or improper urethral anastomosis and ischemia at the anastomic site. The mucous membrane of prostatic urethra retracts after opening the proximal part of the urethral stricture, making it difficult to include in the suture line [14]. Importantly, this inadequate fixation of the healthy prostatic mucosa might cause a localized soft mucosal narrowing at the site of anastomosis with underlying fibrosis [15]. In addition, scar tissue around the urethral anastomosis, which has not been removed completely during urethroplasty, may cause the urethral contracture.

We thought that a long urethral defect might require a more extensive urethral dissection for securing tension-free anastomosis, which may lead to a high possibility of surgical complications, such as refractory urethral contracture. As was expected, initial length of urethral defect before the PRPFUI was associated with the success rate of a subsequent IU for urethral contracture. On the other hand, the length of urethral contracture following PRPFUI is important for attempting IU. It was reported that patients with stricture lengths of <10 mm had higher success rates with IU than those with stricture lengths >10 mm [16]. It seems that the longer the urethral contracture, the higher the chance of recurrence of urethral contracture. In our study, the length of urethral contractures before IU was less than 10 mm in all patients. Therefore, we did not evaluate the length of urethral contracture before IU as a predictor of IU success.

In general, the length of urethral contracture can be exactly measured with combined retrograde urethrogram and voiding cysto-urethrogram. Magnetic resonance imaging can be helpful to understand not only the status of contracture but also pelvic anatomy including intact part of urethra, corpus cavernosum, and urinary bladder. Combined cysto-urethrogram is also essential to measure the length of urethral contracture. In this study, the length of urethral contracture in all 35 IU patients could be measured with retrograde urethrogram because the urethral contractures were passable, which means contrast material could pass through the contracture portion.

Urethral lengthening procedures are commonly applied to approximate free urethral ends during posterior urethroplasty. There was no significant difference in urethral lengthening procedure between the two outcome groups of first IU (Table 2). However, there was significant difference in urethral lengthening procedure between the two outcome groups of second IU (Table 3). We expected that urethral lengthening procedures would have a role in successful outcome of IU because multistep procedures mean more complex urethral injury and longer urethral defect. In our study, most patients underwent multiple urethral lengthening procedures such as urethral rerouting. There were a very small number of patients with only urethral mobilization procedure. Of course this is quite understandable because patients with more complex urethral injury and longer urethral defect will likely have high possibility of urethral contracture recurrence. These statistical results may be attributed to such an imbalance of patient number. On the other hand, the success rate of first IU in patients with urethral mobilization only was 50% (1/2 patients), however, the success rate of first IU with urethral rerouting was 21% (4/19 patients, Table 2). It is presumed that IU was very difficult in patients with PRPFUI including urethral rerouting because a course of urethra had been changed.

Another important point to consider is how many times IU can be performed for urethral contracture. Pansadoro and colleagues reported that there is no increase in success with a second IU [16]. Our study showed similar results (Table 1), with a success rate of 20% for the second IU, and a success rate of 0% for the third IU and

thereafter. Therefore, we propose that IU more than two times would be ineffective for urethral contracture after PRPFUI.

To our knowledge, the factors affecting the success rate of IU for urethral contracture following PRPFUI have not been previously evaluated. We wanted to answer the following question, "Who is a suitable candidate for IU to treat urethral contractures following PRPFUI?" We hope that our study results can help surgeons select patients who will benefit the most from IU.

This study is retrospective and has some limitations. One of them is that the number of patients who did not want further IU or got lost to follow-up increased as the IU was repeated. In our study, the result of 27 patients was not successful on the first IU (Table 1). Twenty-five of 27 patients agreed to undergo the second IU, but two patients did not. In these two patients, one did not want further IU, and the other got lost to follow-up. If these two patients had undergone subsequent IU, the result of our study might change to some degree. Similarly, 6 of 25 patients had an unsuccessful outcome in second IU and did not want to undergo the third IU. It is assumed that patients might not want further IU or get lost to follow-up because they got disappointed and fatigue by repeated surgical failure. Most patients who did not want further IU preferred a urethral dilation instead of subsequent IU.

We did not evaluate erectile dysfunction of our patients with validated questionnaires. It was reported that injuries of cavernous nerves and pudendal artery branches are often accompanied by the pelvic fracture urethral distraction defects [17]. Erectile dysfunction can be considered as a predictive factor for the outcome of IU because it could be a sign of bad vascularization and neurogenic disorder. Although patients were interviewed on erectile function at each follow-up visit, the data was insufficient, and this can be another limitation of our study. Recently, our ongoing clinical practice has included validated questionnaires of International Index of Erectile Function.

Finally, we did not consider other conditions such as benign prostatic hyperplasia, which may affect the urinary flow rate. However, we think that a condition such as benign prostatic hyperplasia did not affect the results of our study because ages of patients in our study ranged from 18 to 50 and there was no significant difference in age between the two study groups.

Conclusion

Our results support that IU is a feasible initial treatment option for urethral contracture after PRPFUI. Short urethral defect length and no previous surgical failures before PRPFUI are good prognostic factors for IU following PRPFUI.

Conflict of interest

None declared.

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References

[1] 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;67:1033–9.
[2] Basta AM, Blackmore CC, Wessells H. Predicting urethral injury from pelvic fracture patterns in male patients with blunt trauma. J Urol 2007;177:571–5.
[3] Andrich DE, Day AC, Mundy AR. Proposed mechanisms of lower urinary tract injury in fractures of the pelvic ring. BJU Int 2007;100:567–73.
[4] Koraitim MM. Pelvic fracture urethral injuries: the unresolved controversy. J Urol 1999;161:1433–41.
[5] Koraitim M. On the art of anastomotic posterior urethroplasty: a 27-year experience. J Urol 2005;173:135–9.
[6] Morey AF, McAninch JW. Reconstruction of posterior urethral disruption injuries: outcome analysis in 82 patients. J Urol 1997;157:506–10.
[7] Webster GD, Ramon J. Repair of pelvic fracture posterior urethral defects using an elaborated perineal approach: experience with 74 cases. J Urol 1991;145:744–8.
[8] Steenkamp JW, Heyns CF, de Kock ML. Internal urethrotomy versus dilation as treatment for male urethral strictures: a prospective, randomized comparison. J Urol 1997;157:98–101.
[9] van Leeuwen MA, Brandenburg JJ, Kok ET, Vijverberg PL, Bosch JL. Management of adult anterior urethral stricture disease: nationwide survey among urologists in the Netherlands. Eur Urol 2011;60:159–66.
[10] Helmy TE, Hafez AT. Internal urethrotomy for recurrence after perineal anastomotic urethroplasty for posttraumatic pediatric posterior urethral stricture: could it be sufficient. J Endourol 2013;27:693–6.
[11] Al Rifaei MA, Al Rifaei A. Management of postoperative obstruction after bulboprostatic anastomotic urethroplasty for membranous urethral defects secondary to pelvic fracture. Scand J Urol Nephrol 2001;35:491–6.
[12] Singh BP, Andankar MG, Swain SK, Das K, Dassi V, Kaswan HK, et al. Impact of prior urethral manipulation on outcome of anastomotic urethroplasty for post-traumatic urethral stricture. Urology 2010;75:179–82.
[13] Wadhwa SN, Chahal R, Hemal AK, Gupta NP, Dogra PN, Seth A. Management of obliterative posttraumatic posterior urethral strictures after failed initial urethroplasty. J Urol 1998;159:1898–902.
[14] Al-Rifaei MA, Al-Rifaei A. Management of postoperative obstruction after bulboprostatic anastomotic urethroplasty for membranous urethral defects secondary to pelvic fracture. Scand J Urol Nephrol 2001;35:491–6.
[15] Koraitim M. Failed posterior urethroplasty: lessons learned. Urology 2003;62:719–22.
[16] Pansadoro V, Emiliozzi P. Internal urethrotomy in the management of anterior urethral strictures: long-term followup. J Urol 1996;156:73–5.
[17] Shenfeld OZ, Kiselgorf D, Gofrit ON, Verstandig AG, Landau EH, Pode D, et al. The incidence and causes of erectile dysfunction after pelvic fractures associated with posterior urethral disruption. J Urol 2003;169:2173–6.