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TOPIC PAPER

Single-surgeon series of delayed anastomotic urethroplasty for pelvic fracture urethral injury: an analysis of surgical and patient-reported outcomes of a 10-year experience in a Japanese referral center

Akio Horiguchi[1] · Masayuki Shinchi[1] · Kenichiro Ojima[1] · Ayako Masunaga[1] · Keiichi Ito[1] · Tomohiko Asano[1] · Eiji Takahashi[2] · Fumihiro Kimura[2] · Ryuichi Azuma[3]

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Abstract

Purpose To report our experience with delayed anastomotic urethroplasty for pelvic fracture urethral injury (PFUI) during the last 10 years and evaluate both surgical and patient-reported outcomes.

Methods Retrospective analysis of 115 patients undergoing delayed anastomotic urethroplasty for PFUI between 2008 and 2017 by a single surgeon (AH) was performed. Success was defined as a urethral lumen large enough for passage of a 17-Fr flexible cystoscope. We asked patients to complete questionnaires before (baseline) and 1 year after urethroplasty and compared by paired *t* and Wilcoxon signed-rank tests the answers to a question about LUTS-specific QOL and the health-related QOL indicated by EQ-5D index and visual analogue scores (EQVAS). Overall patient satisfaction 1 year after urethroplasty was also evaluated.

Results Urethroplasty was successful in 108 patients (93.9%), and failed urethroplasty was significantly associated with greater intraoperative blood loss ($p=0.009$) and smaller surgical experience ($p=0.018$). Sixty-six patients (57.4%) completed questionnaires 1 year after urethroplasty, and 65 of those 66 (98.5%) were "satisfied" (36.4%) or "very satisfied" (62.1%) with the outcome of their urethroplasty. The LUTS-specific QOL scores ($p<0.0001$), EQ-5D index scores ($p<0.0001$), and EQVAS scores ($p<0.0001$) all improved significantly after urethroplasty.

Conclusions Delayed anastomotic urethroplasty has a high success rate and significant beneficial effects on both LUTS-specific and health-related QOL, resulting in high patient satisfaction. Careful manipulation in a bloodless operative field by experienced surgeons could be the key to successful urethroplasty.

Keywords Pelvic fracture · Urethral injury · Urethroplasty · Patient-reported outcome

Introduction

Pelvic fracture urethral injury (PFUI) is a rare injury accompanying blunt force pelvic fracture [1, 2]. The standard treatment for it is immediate suprapubic tube (SPT) placement followed by delayed anastomotic urethroplasty via a perineal approach [3]. The goals of delayed anastomotic urethroplasty are complete excision of fibrosis covering the disrupted urethral ends, healthy apposition of urethral mucosa, and establishment of tension-free anastomosis [4]. Although delayed anastomotic urethroplasty performed by an experienced surgeon using the proper technique has a high success rate and low complication rate, some injuries can be technically very challenging and the consequences of inadequate or inexpert surgery of even straightforward cases can be devastating [5]. Our institute started serving as a referral center for urethral surgery in 2004 and has become the largest in Japan. We herein report a single-surgeon series of delayed anastomotic urethroplasty for PFUI and analyze patient records to assess factors influencing the surgical outcome. We also evaluated the procedure's effects from the patient's standpoint using validated patient-reported outcome measures.

✉ Akio Horiguchi
impreza@ndmc.ac.jp

[1] Department of Urology, National Defense Medical College, 3-2 Namiki, Tokorozawa, Saitama 359-8513, Japan

[2] Department of Urology, Nishisaitama-chuo National Hospital, Saitama, Japan

[3] Department of Plastic Surgery, National Defense Medical College, Saitama, Japan

Patients and methods

Patients and assessment of urethral gap

A total of 115 patients undergoing delayed anastomotic urethroplasty for PFUI between January 2008 and November 2017 by a single surgeon (AH) were retrospectively reviewed after obtaining approval of our institutional review board. At least 3 months after a patient's injury or the last urethral manipulation, the urethral gap length was evaluated on retrograde and antegrade urethrography [6]. Bladder neck competence and the site of proximal disruption (i.e., disruption in the prostatic to membranous urethra or in the bulbomembranous urethra) were also evaluated by antegrade flexible cystoscopy through the SPT tract. In 99 cases (86.1%), preoperative MRI was undergone and its finding was taken into consideration for selecting the repair type as described previously [7].

Urethroplasty

All urethroplasties were anastomotic performed by a single surgeon (AH) in a stepwise fashion as described elsewhere [8]. In short, after a midline perineal incision was made, the bulbar urethra was divided at the obliterated segment and then mobilized distally. The covering fibrotic scar tissue was completely removed until normal healthy tissue was encountered. Eight anastomotic 4-0 polydioxanone sutures reapproximating the urethral mucosa were placed over a 16-Fr catheter. If the proximal urethral end was not identified or a tension-free anastomosis could not be achieved, corporal splitting and inferior pubectomy were used in steps. For patients with concomitant rectal injury and/or those who had only a limited length of bulbar urethra due to prior failed urethroplasty, an abdomino-perineal approach was used.

Postoperative follow-up and assessment of surgical and patient-reported outcomes

Patients were in principle followed up postoperatively at 3, 6, and 12 months and thereafter annually using questionnaires, uroflowmetry, and flexible cystoscopes. Success was defined as having a urethral lumen large enough for passage of a 17-Fr flexible cystoscope. Questionnaires included a construct evaluating lower urinary tract symptoms (LUTS) consisting of six questions to generate a total score and a separate LUTS-specific quality of life (QOL) question from the International Consultation on Incontinence Questionnaire Male Lower Urinary Tract Symptoms (ICIQ-MLUTS) [9, 10], health-related QOL indicated by EQ-5D index and visual analogue scores (EQVAS) [11], urinary continence status by ICIQ-SF [12] and amount of daily pad use, and erectile function by IIEF-5 [13]. Overall patient satisfaction after urethroplasty was evaluated by asking patients to choose "very satisfied", "satisfied", "unsatisfied", or "very unsatisfied" 1 year after urethroplasty.

Statistical analysis

Statistical significance was evaluated with a Mann–Whitney *U* test, Chi square test, paired *t* test, or Wilcoxon signed-rank test. Univariate and multivariate logistic regression analyses were used to assess the predictive value of factors associated with surgical outcome and patient satisfaction.

Results

Patient characteristics

The median (interquartile range—IQR) age of the patients was 38 (25–55) years. The initial management was SPT placement in 93 patients (80.9%) and primary realignment in 22 (19.1%). Three urethroplasties (2.6% of the 115 in this series) were performed from 2004 to 2010, 4 (3.5%) in 2011, 7 (6.1%) in 2012, 13 (11.3%) in 2013, 23 (20.0%) in 2014, 21 (18.3%) in 2015, 15 (13.0%) in 2016, and 29 (25.2%) in 2017. The median (IQR) time between the injury and urethroplasty was 12 (10–27) months. Thirty-eight patients (33.0%) had previous history of transurethral treatment including urethrotomy, dilation, and/or temporary urethral stenting at least once and 12 (10.4%) had previous history of urethroplasty for PFUI at least once. The median (IQR) urethral gap length was 16.8 (10.6–25.4) mm. The bladder neck was intact in 106 patients (92.2%) and opened in 9 (7.8%). The urethra was disrupted distal to the external sphincter in 70 (60.9%) and disrupted between the prostatic apex and membranous urethra in 45 (39.1%).

Surgical outcome

Urethroplasty was performed with only urethral mobilization in 9 patients (7.8%), with urethral mobilization + corporal splitting in 41 patients (35.7%), with urethral mobilization + corporal splitting + inferior pubectomy in 58 patients (50.4%), and with an abdomino-perineal approach in 7 patients (6.1%). The median (IQR) operative time was 218 (185–271) min and the median (IQR) blood loss was 171 (80–337) ml. Postoperative complications were compartment syndrome in the lower limb in one patient (0.9%), peroneal nerve paralysis in two patients (1.7%), scrotal hematoma in three patients (2.6%), and surgical site infection in one patient (0.9%). All these complications were grade 1 according to the Clavien–Dindo classification

and were treated conservatively. Urethroplasty was successful in 108 patients (93.9%). Five of the seven patients with a failed urethroplasty could void without additional intervention but had a urethral lumen too small for cystoscope passage, and two could not void and were subsequently salvaged by transpubic anastomotic urethroplasty. The median (IQR) postoperative follow-up was 36 (14–50) months. The median (IQR) time from urethroplasty to failure was 92 (90–248) days. The urethroplasty failure rate was significantly higher in the 1st third of our surgical experience ($p = 0.018$), and blood loss was significantly greater in failed urethroplasties ($p = 0.009$, Table 1). In univariate logistic regression analysis, the significant predictors of the failed urethroplasty were less surgical experience (OR 6.21, 95% CI 1.14–33.72, $p = 0.03$) and greater blood loss (OR 1.003, 95% CI 1.001–1.005, $p = 0.003$, Table 2). In multivariate analysis, only greater blood loss was an independent predictor of failed urethroplasty (OR 1.003, 95% CI 1.000–1.005, $p = 0.03$, Table 2).

Patient-reported outcome

Sixty-six patients (57.4%) completed questionnaires 1 year after urethroplasty. The mean LUTS-specific QOL score improved significantly from 2.7 at baseline to 0.9 1 year after urethroplasty (mean difference 1.8, $p < 0.0001$). The mean EQ-5D index score and EQVAS score improved significantly from 0.49 and 53.2 at baseline to 0.78 and 73.5 1 year after urethroplasty (mean differences 0.29 and 20.3, $p < 0.0001$ and $p < 0.0001$). Forty-six of 66 patients (70.0%) achieved pad-free status. Fifty-eight (87.9%) had moderate to severe preoperative erectile dysfunction assessed by IIEF-5 score, and 53 (80.3%) had moderate to severe postoperative erectile dysfunction [13]. There was no significant difference between preoperative and postoperative IIEF-5 score (mean of difference 0.5, 95% CI 2.1–1.2, $p = 0.57$). Sixty-five of 66 (98.5%) were either "satisfied" (41, 62.1%) or "very satisfied" (24, 36.4%) with the outcome of their urethroplasty and one (1.5%) was "unsatisfied". The Peeling's picture score

Table 1 Association of perioperative factors with surgical outcome

Parameters	Successful	Failed	*p*
Number of patients	108	7	
Age, median (IQR)	38 (25–54)	38 (19–58)	0.67
BMI, median (IQR)	22.3 (20.2–24.9)	21.9 (20.9–24.1)	0.97
Initial treatment (%)			
PR	20 (90.9)	2 (9.1)	0.51
SPT only or failed PR	88 (94.6)	5 (5.4)	
Surgical experience (%)			
1st third	31 (86.1)	5 (13.9)	0.018
2nd and 3rd thirds	77 (97.5)	2 (2.5)	
Urethral gap length, mm, median (IQR)	16.6 (10.6–25.3)	17.5 (11.6–26.8)	0.83
Prior DVIU/dilation/stenting (%)			
No	74 (96.1)	3 (3.9)	0.16
Yes	34 (89.5)	4 (10.5)	
Initial or salvage urethroplasty (%)			
Initial	96 (93.2)	7 (6.1)	0.35
Salvage	12 (100)	0 (0)	
Bladder neck (%)			
Intact	100 (94.3)	6 (5.7)	0.51
Open	8 (88.9)	1 (11.1)	
Disruption site (%)			
Bulbomembranous	68 (97.1)	2 (2.9)	0.07
Membranous-prostate	40 (88.9)	5 (11.1)	
Surgical approach (%)			
Urethral mobilization	9 (100)	0 (0)	0.61
Urethral mobilization + corporal splitting	39 (95.1)	2 (4.9)	
Urethral mobilization + corporal splitting + inferior pubectomy	53 (91.4)	5 (8.6)	
Abdomino-perineal approach	7 (100)	0 (0)	
Operative time, min, median (IQR)	217 (183–268)	255 (194–337)	0.29
Blood loss, ml, median (IQR)	162 (78–304)	383 (233–1434)	0.009

(mean 2.0) and ICIQ-SF total score (mean 3.9) of "very satisfied" patients were significantly lower than those of "satisfied" or "unsatisfied" patients (mean 2.6 and mean 7.8, $p=0.01$ and $p=0.028$, respectively, Table 3). Multivariate logistic regression analysis showed that lower Peeling's picture score (OR 0.40, 95% CI 0.16–1.00, $p=0.04$) and lower ICIQ-SF score (OR 0.87, 95% CI 0.78–0.98, $p=0.02$) were independent predictors of "very satisfied" patients (Table 4).

Discussion

A nationwide survey of surgical management of PFUI by Japanese consultant urologists revealed that in their whole career, 60% of them had experienced fewer than three patients with PFUI and only 5% of them had operated on more than ten patients, suggesting most Japanese urologists are not familiar with delayed urethroplasty [14]. Our center is one of the few institutes in Japan dealing with urethroplasty as a daily practice. It has been reported that technical inexperience of the surgeon is the most common cause of failed urethroplasty [15]. At the first third of our experience, the success rate is less than 90%. In total, however, our success rate exceeded 90% and seems comparable to rates reported for other experts [16–18]. Mundy recommended that surgeons who are not performing more than 15 urethroplasties a year should be referring patients to specialized centers where the caseload is sufficient to maintain expertise [19]. The surgical skill for PFUI repair is not mandatory for every urologist, and patients with PFUI should be referred to specialists for urethral reconstruction.

The most difficult parts of delayed urethroplasty are identifying the disrupted proximal urethral end and making an anastomosis in a small operative field in the perineum. Ancillary techniques such as corporal separation and inferior pubectomy widen the exposure and facilitate further

Table 2 Predictor of failed urethroplasty

Parameters	Univariate		Multivariate	
	OR (95% CI)	*p*	OR (95% CI)	*p*
Age	0.99 (0.95–1.04)	0.92		
Initial primary realignment	1.76 (0.32–9.73)	0.53		
Surgical experience	6.21 (1.14–33.72)	0.03		
Urethral gap length (mm)	1.01 (0.94–1.08)	0.88		
Prior treatment (yes)	2.46 (0.52–11.55)	0.25		
Operative time (min)	0.99 (0.98–1.01)	0.49		
Blood loss (ml)	1.003 (1.001–1.005)	0.003	1.003 (1.000–1.005)	0.03

Table 3 Relation of patient satisfaction and parameters ($n=66$)

	Very satisfied	Satisfied or unsatisfied	*p*
Number of patients	41	26 (25 satisfied and 1 unsatisfied)	
Successful urethroplasty (%)	39 (95.1)	24 (96.0)	0.86
LUTS total score, mean (SD)	4.2 (4.5)	5.9 (4.4)	0.06
Peeling's picture score, mean (SD)	2.0 (0.7)	2.6 (1.0)	0.01
Q_{max}, ml/s, mean (SD)	20.9 (9.1)	21.2 (12.0)	0.91
Post void residual, ml, mean (SD)	41.3 (53.2)	21.6 (21.5)	0.08
ICIQ-SF total score, mean (SD)	3.9 (5.0)	7.8 (5.9)	0.006
Fraction pad free (%)	32 (78.1)	14 (52.0)	0.028
IIEF-5 score, mean (SD)	8.1 (5.1)	6.5 (4.2)	0.19

Table 4 Logistic regression analysis to predict "very satisfied" ($n=66$)

	Univariate		Multivariate	
	OR (95% CI)	*p*	OR (95% CI)	*p*
Successful urethroplasty	1.23 (0.11–14.32)	0.87		
LUTS total score	0.92 (0.82–1.03)	0.14		
Peeling's picture score	0.45 (0.23–0.87)	0.01	0.40 (0.16–1.00)	0.04
ICIQ-SF total score	0.88 (0.79–0.97)	0.006	0.87 (0.78–0.98)	0.02
IIEF-5 total score	1.08 (0.96–1.22)	0.18		

proximal dissection and tension-free repair. The reported percentages of PFUI patients requiring inferior pubectomy differ widely [16, 20–23]. Some authors report that bulbar urethral mobilization with the patient in the high lithotomy position is itself sufficient for successful urethroplasty in a high percentage of patients and further ancillary maneuvers are rarely needed, especially in patients initially treated with primary realignment [22]. The ratio of patients needing ancillary techniques in our study, in contrast, was high, possibly because of differences in anatomic characteristics, surgical experience, and/or severity of injury. Andrich et al. commented that familiarity with the next surgical step makes one more inclined to proceed with it, even when it is not actually necessary [20]. Urethral surgeons should, however, be able to take those steps when needed [20].

Two major complications after PFUI are erectile dysfunction and urinary incontinence. The incidence of erectile dysfunction varied widely, and erectile dysfunction is thought to be due to the original pelvic fracture rather than delayed urethroplasty itself [16, 24]. Koraitim reported that 34 of 90 patients (37.8%) who had PFUI exhibited moderate to severe erectile dysfunction assessed by IIEF-5 score [24]. In our cohort, the ratio of patients having erectile dysfunction seems to be higher than the ratios reported by others. One plausible explanation for the discrepancy is that we assessed sexual function too early. Koraitim reported that spontaneous recovery of sexual function could occur up to 2 years after injury and the preferable time to assess sexual function is 2 years post-injury [24]. Although pelvic trauma can put the continence mechanism in jeopardy, the continence after repair has been reported to be adequate. Cooperberg et al. investigated the postoperative voiding function in 103 men accessible after delayed urethroplasty and found that nearly 90% of them reported no symptoms of incontinence [21]. Fu et al. reported that 63 of 510 patients (11%) had incontinence, 24 of whom (38.1%) had urgent incontinence [25]. In our series, 20 of 66 (30%) used pads postoperatively and patients who were "very satisfied" had ICIQ-SF scores significantly lower than those who were "satisfied" or "unsatisfied", suggesting that appropriate management of continence could further improve patient satisfaction. Detailed analysis on incontinence with regard to the type of incontinence, amount of urine leakage by pad test, and serial monitoring of incontinence is needed in our next study.

Our study has only short-term results with a median postoperative follow-up of 36 months. Mundy commented that he never sees a patient with a widely patent urethra on urethrography and a normal flow rate 6 months postoperatively who shows signs of deterioration thereafter [5]. In line with this comment, the time from urethroplasty to failure was less than 1 year for all the seven patients with failed urethroplasty in our series. Despite the limitation, our study is the first and the largest series of delayed urethroplasty for PFUI in Japan and could have significant impact on the strategy of Japanese urologists managing PFUI.

Conclusions

Delayed anastomotic urethroplasty for PFUI has a high success rate and significant beneficial effect on both LUTS-specific QOL and health-related QOL. Careful manipulation in a bloodless operative field by an experienced hand could be the key for successful urethroplasty, and management of postoperative continence might improve patient satisfaction.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Research involving human participants and/or animals All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent For this type of study, formal consent is not required.

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