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ORIGINAL ARTICLE

Erectile Function

The relationship between erectile function and complex panurethral stricture: a preliminary investigative and descriptive study

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The aim of this study was to evaluate erectile function in patients with panurethral stricture after urethral reconstruction. Totally, 65 patients were enrolled. Different urethral reconstructions were performed according to the details of urethral strictures. The erectile function was evaluated before and after surgery. The length and location of stricture and duration from initial diagnosis to operation were recorded. The International Index of Erectile Function-5 (IIEF-5) scores, the quality of life (QoL) scores and the maximal flow rate were obtained before and 3, 6, and 12 months after surgery. A significant improvement in QoL and maximal flow rate was observed 3, 6, and 12 months after surgery compared with those observed before surgery ($P < 0.05$). An impairment of erectile function was observed in patients with multi-site stricture 3 months after surgery ($P < 0.05$). Subsequently, these patients recovered 6 and 12 months after surgery. Three months after surgery, the IIEF-5 scores in patients with anterior urethral stricture were higher than those with multi-site stricture. Similar results were observed 6 and 12 months after surgery. No significant difference in age or duration from initial diagnosis to final operation was observed between patients with erectile dysfunction after surgery and patients with normal erectile function. However, a linear regressive relationship was detected between IIEF-5 scores and location of urethral stricture. Surgical reconstruction for treating panurethral strictures has limited effects on erectile function. The location of the stricture, particularly when extended to posterior urethra, was found to be associated with erectile function after surgery.
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Keywords: erectile dysfunction, panurethral stricture, urethral reconstruction

INTRODUCTION

Lesions of the urethra occur in 3%–25% of patients with trauma or after iatrogenic manipulation.[1] Surgical reconstruction for the treatment of urethral stricture disease has recently become the mainstay treatment in refractory cases. Although a marked development of reconstructive techniques has occurred over the last two decades, resulting in the achievement of well-documented success rates have achieved throughout the urological community, the treatment of panurethral strictures remains a challenge for urologists. Due to the length of the urethral stricture, the stricture site may involve both the anterior and posterior urethra, and more than one type of procedure may be used to treat these patients. Many complications, such as recurrent stricture formation, incontinence, and erectile dysfunction, occur more frequently in patients with urethral stricture than in others.[2] Nevertheless, few studies have reported the effect of urethral reconstruction surgery on erectile function in patients with panurethral stricture. In addition, there is no experimental evidence to support the identification of other factors that may influence the erectile function in these patients.

The aim of this study was to evaluate the erectile function in panurethral stricture patients subjected to various types of urethroplasty.

MATERIALS AND METHODS

Patient selection

After obtaining approval from the hospital review board, 55 patients with panurethral stricture secondary to trauma or iatrogenic manipulation were screened for this study between January 2005 and January 2013. All of the patients were in stable sexual relationships. Patients with uncontrolled hypertension, diabetes mellitus, and other major medical co-morbidities were excluded to avoid biases resulting from these diseases. The blood levels of testosterone (T), estradiol (E2), luteinizing hormone, and follicle-stimulating hormone were determined in all of the patients. Patients with abnormal hormone levels were excluded from this study.

Surgical procedures

In the present study, the panurethral strictures were defined as a single urethral stricture or multi-site strictures greater than 10 cm in length.[3] If the strictures were primarily located in the penile and bulbar parts of the urethra, the stricture was defined as an anterior urethral stricture. Multi-segmented strictures extending from the anterior urethra to the membranous and prostatic parts of the urethra were considered multi-site urethral stricture. For patients with anterior urethral strictures, substitutive procedures using different types of grafts or flaps were considered. The resource for the grafts or flaps included the

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buccal mucosa, lingual mucosa, and colonic mucosa. If the patient was diagnosed with multi-site urethral stricture, a substitutive urethroplasty combined with end-to-end anastomosis was performed. During this procedure, an inferior partial pubectomy was considered to achieve free-tension anastomosis in most patients. Most patients in our study were free of catheters within 1 month after surgery.

Peri-operative evaluation

The time interval from the initial diagnosis to the final surgical operation was recorded for each patient. Urethrography examinations were performed in all cases to record the details of the urethral stricture **(Figure 1)**. Pre- and post-operative uroflowmetry was also performed. We defined stricture recurrence as a urinary peak flow of less than 15 ml s^{-1} with an obvious symptom of dysuria. The 5-item International Index of Erectile Function-5 (IIEF-5) and Quality of Life (QoL) Questionnaire were self-administered by the study participants. We evaluated the patient responses before the operation and 3, 6, and 12 months after the operation. All the patients were followed-up via mail or telephone. Non-responding patients were contacted again 2 weeks later. Abnormal erectile function was defined as an IIEF-5 score of < 21[2].

Statistical data

The survey data were tabulated and are expressed as the means ± s.d.. We used a paired *t*-test and chi-squared (χ^2) test to compare the pre- and post-operative data. Specifically, all the variables were subjected to linear regression analysis. All the statistical analyses were performed using SPSS 13.0 (SPSS Inc., USA). $P < 0.05$ was considered as statistically significant.

RESULTS

The detailed characteristics of all of the patients are summarized in **Table 1**. The patients included in the present study had hormone levels within normal ranges.

Suprapubic drainage was performed in all of the patients before the operation. Dorsal lingual mucosa graft substitution was performed in 18 patients, whereas dorsal buccal mucosa graft urethroplasty was performed in 12 patients, and colonic mucosa graft urethroplasty was performed in nine patients. Of the patients receiving substitutive reconstruction with end-to-end anastomosis, the lingual mucosa was used in 20 patients, and the buccal mucosa was used in six patients. No patients received two-stage operations. No fistula complications were detected after surgery. However, penile edema, which subsided within 1–2 weeks, was observed in five patients. In addition, six patients complained of penile shortening.

Obvious improvements in the QoL score and maximal peak flow rate were observed 3 months after surgery ($P < 0.05$). The mean IIEF-5 scores in all cases did not show distinct changes during the 3-month follow-up visit. However, an obvious decrease in the IIEF-5 scores of patients with multi-site urethral stricture was observed 3 months after surgery ($P < 0.05$). Six months after surgery, a statistically significant rebound of erectile function was observed in these patients ($P < 0.05$). No significant changes were observed 12 months after surgery compared with the results obtained after 6 months **(Table 2)**.

A comparison of the IIEF-5 score at each time point showed no statistically significant differences between patients with anterior urethral stricture and patients with multi-site stricture before surgery (12.47 ± 5.69 *vs* 15.27 ± 7.73; $P = 0.13$). However, lower IIEF-5 scores could be noticed in patients with multi-site stricture compared with patients with anterior urethral stricture 3 months after the operation (15.64 ± 8.64 *vs* 4.38 ± 3.73; $P < 0.01$). Furthermore, the difference did not show any obvious change between the 6- and 12-month follow-up period (16.41 ± 5.21 *vs* 9.45 ± 1.84 and 16.38 ± 4.93 *vs* 10.67 ± 1.72; $P < 0.05$).

Of the 65 patients eligible for inclusion, 30 (46.15%) were diagnosed with normal erectile function prior to surgery according to the IIEF-5 criteria, and 24 were considered to have normal erectile function 3 months after surgery. A total of 9 of the 20 patients with obvious erectile dysfunction before surgery due to pelvic fracture or iatrogenic trauma became potent 3 months after surgery, and no changes were observed 6 months after surgery. Further comparisons showed that there was no significant difference in the number of erectile

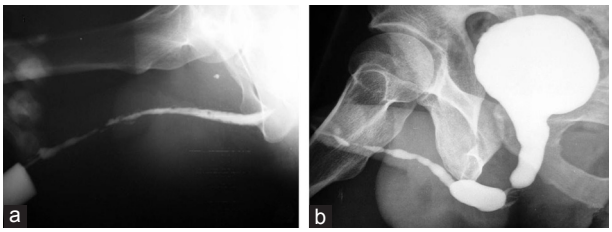

Figure 1: Patients with panurethral stricture confirmed using urethrography. (**a**) Anterior urethral stricture; (**b**) multi-site urethral stricture.

Table 1: Characteristics of 55 male patients with panurethral stricture

	Value range	*Mean±s.d.*	*Patient number (%)*
Age (year)	25–51	40.36±5.02	
Length of urethral stricture (cm)	15–22	11.03±2.36	
Time interval from initial diagnosis to surgical operation (m)	25–47	40.858±3.61	
Location of urethral stricture			
Anterior urethral stricture			36 (55.38)
Multi-site urethral stricture			29 (44.62)
Operation			
Substitutive reconstruction (colon or oral mucosa)			39 (60.00)
Substitutive reconstruction+end-to-end anastomosis			26 (40.00)

s.d.: standard deviation

Table 2: Comparison of the Q_{max}, QoLQ, and IIEF-5 scores before and after urethroplasty in 55 patients with panurethral stricture

	Before surgery	*3 months after surgery*	*6 months after surgery*	*12 months after surgery*
Qmax (ml s^{-1})	2.49±1.23	21.38±4.83*	21.94±4.61	20.32±3.17
Anterior urethral strictures (*n*=36)	5.63±2.53	23.07±5.80*	23.67±5.38	23.94±4.52
Multi-site strictures (*n*=29)	2.49±1.25	19.37±1.96*	19.80±1.93	19.46±2.86
QoL score	5.73±0.68	1.72±0.58*	2.05±0.84	1.88±0.39
Anterior urethral strictures (*n*=36)	5.48±059	1.68±0.57*	2.19±0.97	2.25±0.43
Multi-site urethral strictures (*n*=29)	6.05±0.65	1.77±0.60*	1.87±0.40	1.81±0.52
IIEF-5 score	13.48±6.83	11.81±6.79	12.34±6.87	12.34±6.87
Anterior urethral strictures (*n*=36)	12.47±5.69	15.64±8.64	16.41±5.21	16.38±4.93
Multi-site urethral strictures (*n*=29)	15.27±7.73	4.38±3.73*	9.45±1.84◊	10.67±1.72

*Comparison of the preoperative and 3 months postoperative conditions ($P<0.05$); ◊Comparison of the 3 and 6 months postoperative conditions ($P<0.05$). QoL: quality of life; QoLQ: quality of life questionnaire; IIEF-5: International Index of Erectile Function-5

dysfunction patients with anterior strictures and the number of patients with multi-site urethral strictures before surgery. However, a distinct significant difference was observed between these patients at 3, 6, and 12 months after surgery ($P < 0.05$; **Table 3**).

We attempted to determine the risk factors associated with erectile function in these patients. Unfortunately, there was no significant difference in the age, length of the urethral stricture, or time interval from initial diagnosis and final surgical operation between patients with erectile dysfunction after and patients with normal erectile function **(Table 4)**. Further investigations showed that different types of surgical procedures did not influence the IIEF-5 and QoL scores of these patients after surgery **(Table 5)**.

Moreover, we subjected all of the variables, including age, time interval from initial diagnosis to final surgical procedure, length of urethral stricture, location of urethral stricture, and surgical procedure, to linear regressive analysis to identify the factors that are primarily associated with erectile function in these patients. The results showed a linear regressive relationship between the IIEF-5 scores and the risk factors (F = 2.256, $P = 0.019$). However, only the location of the stricture was included in the final predictor equation **(Table 6)**. The linear predictor equation in the model was IIEF-5 scores = 23.810-9.96X4 (X4 = location of urethral stricture).

DISCUSSION

Much progress has been made in recent years with respect to the treatment of urethral strictures. Several studies concerning new surgical strategies and operative complications are published yearly. As one of the most important complications of urethroplasty, erectile dysfunction after urethral reconstruction has received much attention. Recent data indicate that the incidence of impotence after urethral reconstruction ranges from 16.2% to 72%.[4] However, the relationship between urethral operation and erectile dysfunction in patients with panurethral stricture remains undefined due to limitations in the patient number.[5] Therefore, we collected patient data over a 5-year period to ensure that the final results were objective and useful for further investigation.

In the present study, we used an IIEF-5 questionnaire instead of NPT or penile Doppler ultrasound for the pre- and post-operative evaluation of patients with erectile function. In our experience, most patients refused to allow themselves to be subjected to another penile Doppler ultrasound examination after surgery due to the unpleasant feelings during the measurement. In addition, NPT could not be performed during the follow-up because the patients were not willing to stay another 2 days in the hospital for this test. In contrast, we can obtain relatively accurate details concerning erectile function using an IIEF-5 questionnaire without the need for invasive methods. Therefore, we propose that it is feasible to evaluate patients with erectile function using the IIEF-5 scores after surgery.

In the present study, we first considered the length of urethral stricture in patients with erectile function. Previous studies have suggested that men undergoing repair of longer strictures report ED more often. Coursey *et al*.[6] reported that worse erectile function is more associated with patients with a longer stricture than with those with improved or unchanged erections. These authors further suggested that the length of the urethral stricture is associated with both the severity and magnitude of fibrosis in the urethra and surrounding tissue, which likely leads to the damage of erectile function.[6] Carlton *et al*.[7] also suggested that a shorter urethral stricture results in less opportunity for neurological damage. Nevertheless, there were no significant differences in the length of the urethral strictures between patients with erectile dysfunction after surgery and patients with normal erectile function. Because the mean value of the stricture length was not calculated in previous studies, we propose that the length of the urethral stricture cannot be considered an isolated factor that influences erectile function.

Because the patients in the present study suffered from panurethral stricture, more traumas are likely to occur during urethral reconstruction, suggesting that the influence of the type of urethroplasty on erectile dysfunction is the second factor that we should consider. To avoid bias due to surgery, the same

Table 3: Number of patients diagnosed with erectile function at different time phases

	n (%)			
	Before operation	*3 months after operation*	*6 months after operation*	*12 months after operation*
Anterior urethral strictures	16 (44.44)	12 (33.33)	9 (25.00)	9 (25.00)
Multi-site urethral stricture	19 (65.52)	20 (68.96)	21 (72.41)	21 (72.41)
P	0.90	0.0040	0.000	0.000

Table 4: Comparison of the age, time interval from initial diagnosis to final surgical operation, and length of urethral stricture between patients with normal erectile function after the operation and patients with erectile dysfunction (mean±s.d.)

	Erectile dysfunction (n=30)	*Normal erectile function (n=35)*	*P*
Age (year)	42.19±11.48	40.00±5.93	0.250
Time interval from initial diagnosis to final operation (month)	40.28±5.35	41.42±5.06	0.380
Length of urethral stricture (cm)	13.74±4.01	11.68±3.42	0.084

s.d.: standard deviation

Table 5: Comparison of postoperative IIEF-5 and QoL scores between patients subjected to different types of surgery

	Substitutive reconstruction +end-to-end anastomosis (n=26)	*Substitutive reconstruction (n=39)*	*P*
IIEF-5 (3 months after operation)	12.42±8.71	12.08±6.55	0.718
IIEF-5 (6 months after operation)	12.13±5.76	12.64±7.48	0.852
IIEF-5 (12 months after operation)	12.64±5.11	12.73±6.92	0.671
QoL (3 months after operation)	1.73±1.62	1.41±1.09	0.574
QoL (6 months after operation)	1.39±1.01	1.69±1.38	0.592
QoL (12 months after operation)	1.45±1.13	1.70±1.22	0.671

QoL: quality of life; IIEF-5: International Index of Erectile Function-5

Table 6: Multivariate linear regression model

	Parameter estimate	*Standard error*	*P*
Constant	2.617	0.908	0.006
Age (X1)	0.006	0.087	0.895
Time interval from initial diagnosis to final operation (X2)	0.098	0.088	0.923
Length of stricture (X3)	1.206	0.044	0.233
Location of stricture (X4)	–3.893	0.183	0.003*
Surgical procedure (X5)	–0.012	0.184	0.948

Location of stricture: 1. Anterior urethral stricture; 2. Multi-site urethral stricture. Methods of procedure: 1. Substitutive reconstruction; 2. Substitutive reconstruction+end-to-end anastomosis. *$P<0.05$

surgeon conducted all of the operations. Al-Qudah and Santucci[8] reported that no patients exhibited erectile dysfunction after buccal mucosal onlay graft urethroplasty. Dubey demonstrated that the ED rate after flap or graft urethral reconstruction is < 8%.[9] Mundy[10] also showed that the permanent ED rate is only 5% in patients who underwent anastomotic urethroplasty. Although partial inferior pubectomy was conducted in most patients with multi-site urethral stricture for free tension anastomosis in the present study, this surgical procedure could not be confirmed as a risk factor that affects permanent erectile function through linear regressive analysis. Thus, we conclude that the type of urethroplasty does not affect erectile function in patients with ultra-long urethral stricture.

Further investigation showed an obvious decrease in the IIEF-5 scores in patients with multi-site urethral stricture at 3 months postoperation, whereas no change in the IIEF-5 scores was observed in patients with anterior urethral stricture. In addition, a comparison of the percentages of erectile dysfunction showed an obvious significant difference between patients with anterior and multi-site urethral strictures 3 and 6 months postoperation. Dogra *et al.*[11] suggested that 20% of patients with anterior urethral stricture experience erectile dysfunction after urethroplasty. It has been shown that anterior urethral stricture negatively impacts erectile function after surgery. Lue *et al.*[12] showed that, even though cavernous nerve fibers pass through the tunica albuginea to supply the corpus spongiosum, most of these fibers remain 3 mm outside of this area, occupying the 1 and 11 o'clock positions at the level of convergence of the crura of the corpora cavernosa, the 9 and 3 o'clock positions at the level of the membranous part of the urethra, and the 5 and 7 o'clock positions at the level of the bulbar part of the urethra.[12] Because the type of surgical procedure has little effect on erectile function, we propose that severe edema and inflammation are responsible for erectile dysfunction after surgery. Edema in the tissue surrounding the posterior urethra is more likely to impair the cavernous nerve fibers, potentially leading to the observed erectile dysfunction after surgery. This factor could explain the observation that more patients with multi-site urethral stricture experienced erectile dysfunction 3, 6, and 12 months postoperation. With the gradual subsiding of edema and inflammation, patients with erectile function can recover during a long-term follow-up. Therefore, a statistically significant recovery of erectile function can be observed in patients with multi-site urethral stricture at 6 months after surgery, and patients with erectile function were shown to remain stable after 6 months postoperation.

In addition, Erickson *et al.*[13] showed that men with advanced ages and a greater number of comorbidities may also compromise sexual function prior to urethroplasty. Other studies have considered that the time interval between the urethral trauma and surgical operation may be associated with the recovery of patients with erectile function.[7] Therefore, we attempted to characterize the relationship between these factors and erectile function in the present study. However, no significant differences in the age and time interval from initial diagnosis to surgical operation were observed between patients with erectile dysfunction after surgery and patients with normal erectile function. In addition, the linear regressive analysis did not show an intimate relationship. Based on these results, we concluded that age and the time interval from initial diagnosis to surgical operation do not have an obvious influence on erectile function in patients with ultra-long urethral stricture.

Several limitations existed in the present study. Because long urethral stricture is a special case of urethral stricture disease, the number of patients should be further expanded to enhance the reliability of these results. Thus, the patients can be divided into some subgroups depending on the etiology of the stricture and/or the surgical approach for further investigation. The range of ages should be larger because the age of most of the patients included in the present study ranged from 30 to 40 years. The erectile function in younger and older patients with panurethral stricture should be further examined in future studies.

CONCLUSIONS

The results obtained in the present study indicate that the surgical procedure used for the treatment of panurethral stricture has a limited effect on erectile function. The impairment of erectile function was only associated with the location of the urethral stricture itself. Thus, this factor can be used to predict the erectile function after surgery of patients with ultra-long urethral stricture in the near future.

AUTHOR CONTRIBUTIONS

HX participated in the design and coordination of the study and drafted the manuscript. YMX conceived the study and approved the final version of the manuscript for publication. QF, YLS, and YQ coordinated the study, performed the statistical analysis, and drafted the manuscript. All of the authors read and approved the final manuscript.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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