Urologia
Internationalis

Original Paper

Urol Int 2021;105:269–277
DOI: 10.1159/000512065

Received: August 9, 2020
Accepted: September 25, 2020
Published online: December 17, 2020

Factors Predicting Urethral Stricture Recurrence after Dorsal Onlay Augmented, Buccal Mucosal Graft Urethroplasty

Osama Shalkamy Hassan Abdelazim Ahmed Elshazly Ahmed Soliman Mohammed Agha Ibrahim Tagreda Mohammed Hindawy Ayman Kotb Mamdouh Farid Abul-fotouh Ahmed

Department of Urology, Faculty of Medicine, Al-Azhar University, Cairo, Egypt

Keywords
Urethral stricture · Urethroplasty · Risk factors · Recurrence

Abstract
Introduction: This study was carried out to identify the predictors of urethral stricture recurrence after dorsal onlay buccal mucosal graft (BMG) urethroplasty. ***Materials and Methods:*** The medical records of patients with anterior urethral stricture who underwent dorsal onlay BMG urethroplasty at a single tertiary medical center during the period from March 2010 to January 2018 were reviewed. Only patients with ≥2-year follow-up were included. Data regarding patient demographics, clinical characteristics, stricture characteristics, postoperative course, and adverse events were recorded. Kaplan-Meier analysis was used to assess the recurrence-free survival and likelihood of stricture recurrence. Cox regression analysis was used to identify potential independent predictors of stricture recurrence. ***Results:*** This study included 266 patients with a mean age of 37.71 years and a mean follow-up period of 49.77 months. From the overall study cohort, 34 (12.8%) reported stricture recurrence and 232 (87.2%) were not. The mean recurrence-free time was 79.93 months and mean time to recurrence was 21.59 months. On multivariate analysis, obesity (hazard ratio (HR): 6.02; 95% conference interval (CI): 1.91, 19.03: p = 0.002), inflammatory aetiology (HR: 9.13; 95% CI: 3.50, 23.81; p < 0.001), prior urethroplasty (HR: 8.81; 95% CI: 3.26, 23.86; p < 0.001), penile stricture location (HR: 3.09; 95% CI: 1.10, 8.71; p = 0.033), and stricture length >4.5 cm (HR: 6.83; 95% CI: 1.69, 27.62; p = 0.007) were the significant independent predictors of stricture recurrence. ***Conclusions:*** Dorsal onlay BMG urethroplasty has a reasonable recurrence-free rate with acceptable postoperative complications. Obesity, inflammatory etiology, prior urethroplasty, penile stricture location, and longer stricture were the factors associated with urethral stricture recurrence.

© 2020 S. Karger AG, Basel

Introduction

Urethral stricture disease affects about 1% of adult males, and its treatment costs about $200 million per year in the USA [1]. It has a wide spectrum of presentations ranging from lower urinary tract symptoms, urinary tract infection, acute urinary retention, and stone formation to renal damage and life-threatening conditions [2]. The

karger@karger.com
www.karger.com/uin

© 2020 S. Karger AG, Basel

Karger

Abul-fotouh Ahmed
Department of Urology, Faculty of Medicine, Al-Azhar University
1 Al-Mokhaym Al-Daem, Nasr City
Cairo 11633 (Egypt)
abulfotouhahmed@yahoo.com

Downloaded by:
Seoul Nat'l Medical School
147.46.181.251 - 4/1/2021 7:28:19 AM

treatment options include dilation, direct visual internal urethrotomy, and urethroplasty. In general, urethroplasty is the most effective option for almost all strictures, and it is considered the gold standard for long, complex, or recurrent strictures [3, 4].

Since the description of dorsal onlay free graft urethroplasty by Barbagli and his colleagues [5], the procedure has gained universal application for the treatment of penile and bulbar urethral strictures [6, 7]. Currently, the buccal mucosal graft (BMG) is the most commonly used graft for substitution urethroplasty due to its favorable availability, effortless harvesting, and durable integration in the urethra [6–9]. BMG urethroplasty was used in bulbar, penile, and even panurethral strictures with excellent success and quality of life [10]. It can be used with different techniques, including ventral onlay [11], dorsal inlay [12], or dorsal onlay urethroplasty [13].

Despite the high urethral patency rate after urethroplasty [7, 14, 15], about 10% of cases develops stricture recurrence and require further management. Until now, there is a discrepancy in the literature regarding risk factors for stricture recurrence after urethroplasty. These discrepancies could be related to the heterogeneity of the study population, stricture etiology, surgeon's experience, and duration of follow-up.

The purpose of this study was to identify the risk factors associated with stricture recurrence after BMG urethroplasty for anterior urethral strictures. We hypothesized that studying risk factors of stricture recurrence for specialized technique with a long period and constant follow-up may give more realistic results than previously reported.

Materials and Methods

A retrospective review of medical records was performed to identify patients who underwent urethroplasty with dorsal onlay BMG at a tertiary care hospital in Egypt during the period from March 2010 to January 2018. Only patients with complete medical records who were ≥2 years out of surgery were included. The institutional review board approved the study protocol (ClinicalTrials.gov NCT04357080), and data were recorded without patients' identification.

All surgical procedures were performed by 2 teams of surgeons, 1 for graft harvesting, and the other for urethroplasty. The main operator of the urethroplasty team has an experience with urethral reconstructive surgeries for >10 years. As described elsewhere [5, 16], a one-stage dorsal onlay urethroplasty technique was performed, and BMG was used in all cases. Under general anesthesia with the patient in lithotomy position, a midline perineal and/or penile incision was made. The strictured urethra was circumferentially mobilized off the tunica albuginea of the corpora cavernosa. A dorsal stricturotomy was made until healthy; good caliber urethra was noted on either side of the stricture. The decision to perform the nontransected augmented technique was based predominantly on the intraoperative findings of stricture length and degree of urethral obliteration as well as the appearance of the mucosa and spongy tissue. The cheek or cheek-lip mucosal graft was used in all cases. The defatted graft was positioned on the tunica albuginea of the corpora cavernosa. Anastomosis of the graft to the urethral plate on either side was done after silicone urethral catheter left in situ. The wound was closed in layers with or without a suction drain.

Postoperatively, all patients were scheduled for prospectively planned regular follow-up. Patients were followed up every 3 months in the first year and then annually. Uroflowmetry was performed at each follow-up visit, urethrography at 6 months, and rigid urethroscopy at 9 months. Patients with favorable imaging and endoscopic findings at 9 months were followed up symptomatically. Patients with unfavorable findings and those who developed obstructive voiding symptoms or had a maximum urinary flow rate of ≤14 mL/s were scheduled for imaging and endoscopic reevaluation as required. The need for further intervention, including urethral dilation, was considered stricture recurrence.

The collected data included age, BMI, smoking status, diabetes status, comorbidities, stricture etiology, prior endoscopic treatment, prior urethroplasty, stricture length, stricture location, and urethral plate width. The data regarding total operative time, hospital stay, and postoperative complications were also included.

Characterization of stricture was based on the preoperative urethrography and urethroscopy, and intraoperative findings. The urethral plate width was measured intraoperatively at 3 different points, and the mean was calculated and recorded.

Statistical Analysis

Statistical analysis was performed using the SPSS program, ver. 25. Continuous variables were summarized with mean and standard deviation, range, median, and interquartile range. Categorical variables were summarized with numbers and percentages. Independent sample *t* test or Mann-Whitney U test was used for comparison of continuous variables between groups, and the χ^2 test or Fisher's exact test for comparison of categorical variables. Stricture recurrence rates and recurrence-free probabilities were estimated using the Kaplan-Meier method. The association of variables with stricture recurrence was evaluated using Cox proportional-hazard regression analysis and summarized with HR and 95% CI. Univariate and multivariate analysis models were used. Only factors found to be associated with urethral restructure in univariate analysis were entered into the multivariate model. All statistical tests were two-tailed, and p value <0.05 was considered significant.

Results

Over the study period, 278 patients underwent dorsal onlay BMG urethroplasty. From them, 12 patients were excluded due to incomplete medical records or follow-up. This study comprised 266 patients with a mean age of 37.71 years and a mean follow-up period of 49.77 months.

Downloaded by:
Seoul Nat'l Medical School
147.46.181.251 - 4/1/2021 7:28:19 AM

Table 1. Demographics and clinicopathologic parameters of study cohort

Variables	Overall (n = 266)	Recurrence, (n = 34)	No recurrence, (n = 232)	p value
Age, years				
Mean (SD)	37.71 (14.32)	39.00 (12.49)	37.52 (14.58)	0.393
Min, max	14, 67	20, 61	14, 67	
Median (IQR)	37 (22)	44 (28)	36.5 (24)	
Age categories, n (%)				
≤37 years	138 (51.9)	16 (47.1)	122 (52.6)	0.547
>37 years	128 (48.1)	18 (52.9)	110 (47.4)	
BMI				
Mean (SD)	22.85 (3.25)	23.88 (3.98)	22.70 (3.11)	0.063
Min, max	18, 33	18, 32	18, 33	
Median (IQR)	22 (3)	23 (2)	22 (3)	
BMI categories, n (%)				
Normal/over-weight	250 (94.0)	28 (82.4)	222 (95.7)	0.002
Obese	16 (6.0)	6 (17.6)	10 (4.3)	
Smoking, n (%)	84 (31.6)	10 (29.4)	74 (31.9)	0.771
DM, n (%)	32 (12.0)	4 (11.8)	28 (12.1)	>0.999
CCI categories, n (%)				
0, 2	213 (80.1)	28 (82.4)	185 (79.7)	0.722
>2	53 (19.9)	6 (17.6)	47 (20.3)	
Stricture etiology, n (%)				
Idiopathic	68 (25.6)	4 (11.8)	64 (27.6)	0.048
Inflammatory	36 (13.5)	16 (47.1)	20 (8.6)	<0.001
Iatrogenic	96 (36.1)	6 (17.6)	90 (38.8)	0.016
Trauma	66 (24.8)	8 (23.5)	58 (25.0)	0.853
Previous endoscopic treatment, n (%)	186 (69.9)	24 (70.6)	162 (69.8)	0.928
Repeated endoscopic treatment, n (%) (186 cases)				
1	82 (44.1)	10 (41.7)	72 (44.4)	0.798
>1	104 (55.9)	14 (58.3)	90 (55.6)	
Previous urethroplasty, n (%)	16 (6.0)	8 (23.5)	8 (3.4)	<0.001
Preoperative Q_{max}, mL/s				
Mean (SD)	4.87 (2.23)	5.29 (2.45)	4.80 (2.19)	0.439
Min, max	1.0, 11	2, 10	1, 11	
Median (IQR)	5 (3)	4.5 (4)	5 (3)	
Preoperative Q_{max} categories, n (%)(266 cases)†				
<5 mL/s	118 (54.1)	16 (50.0)	102 (54.8)	0.775
≥5 mL/s	100 (45.9)	16 (50.0)	84 (45.2)	
Stricture site				
Bulbar	128 (48.1)	10 (29.4)	118 (50.9)	0.019
Bulbopenile	108 (40.6)	16 (47.1)	92 (39.7)	0.412
Penile	30 (11.3)	8 (23.5)	22 (9.5)	0.016
Stricture length, cm				
Mean (SD)	5.28 (2.68)	7.12 (3.47)	5.00 (2.43)	<0.001
Min, max	2.5, 14.5	3, 14	2.5, 14.5	
Median (IQR)	4.5 (2.5)	6 (3.3)	4.5 (2)	
Stricture length categories, n (%)				
≤4.5 cm	134 (50.4)	4 (11.8)	130 (56.0)	<0.001
>4.5 cm	132 (49.6)	30 (88.2)	102 (44.0)	
Urethral plate width, mm				
Mean (SD)	6.54 (1.77)	7.0 (0.70)	6.47 (1.86)	0.007
Min, max	4, 12	6, 8	4, 12	
Median (IQR)	7 (2)	7 (1)	6 (2)	
Urethral plate width categories, n (%)				
≥7 mm	134 (50.4)	26 (76.5)	108 (46.6)	0.001
<7 mm	132 (49.6)	8 (23.5)	124 (53.4)	

Age, CCI, Q_{max}, urethral stricture length, and urethral plate width were stratified according to the median values. DM, diabetes mellitus; CCI, Charlson comorbidity index; IQR, interquartile range; Q_{max}, maximum urinary flow rate; SD, standard deviation.
† Uroflowmetry was inconclusive in 48 cases and their data were excluded from analysis.

Downloaded by:
Seoul Nat'l Medical School
147.46.181.251 - 4/1/2021 7:28:19 AM

Table 2. Univariate and multivariate Cox regression models for the variables associated with urethral stricture recurrence

Variables	Univariate analysis		Multivariate analysis	
	HR (95% CI)	*p* value	HR (95% CI)	*p* value
Age >37 years	1.22 (0.62, 2.39)	0.568	–	
Obesity	3.19 (1.30, 7.83)	0.011	6.02 (1.91, 19.03)	0.002
Smoking	0.95 (0.45, 1.99)	0.898	–	
DM	0.92 (0.32, 2.63)	0.881	–	
Charlson comorbidity index >2	0.83 (0.34, 2.01)	0.681	–	
Stricture etiology				
Idiopathic	0.41 (0.14, 1.16)	0.093	–	
Inflammatory	7.37 (3.73, 14.53)	<0.001	9.13 (3.50, 23.81)	<0.001
Iatrogenic	0.27 (0.11, 0.70)	0.007	0.77 (0.22, 2.68)	0.681
Trauma	1.01 (0.45, 2.24)	0.989	–	
Previous endoscopic treatment	1.06 (0.51, 2.23)	0.874	–	
Endoscopic treatment >1	1.04 (0.46, 2.36)	0.922	–	
Previous urethroplasty	6.03 (2.70, 13.43)	<0.001	8.81 (3.26, 23.86)	<0.001
Preoperative Q_{max} <5 mL/s	1.21 (0.60, 2.42)	0.593	–	
Stricture location				
Bulbus	0.40 (0.19, 0.84)	0.015	0.96 (0.40, 2.40)	0.975
Bulbopenile	1.38 (0.70, 2.72)	0.346	–	
Penile	2.83 (1.27, 6.31)	0.011	3.09 (1.10, 8.71)	0.033
Stricture length >4.5 cm	8.12 (2.86, 23.05)	<0.001	6.83 (1.69, 27.62)	0.007
Urethral plate width <7 mm	0.30 (0.14, 0.66)	0.003	0.44 (0.19, 1.04)	0.062

The studied variables were categorized according to median. DM, diabetes mellitus; SD, standard deviation; IQR, interquartile range; HR, hazard ratio; CI, confidence interval.

The most commonly reported urethral stricture etiology was iatrogenic (36.1%), and 69.9% of patients had a prior history of urethral stricture treatment. The stricture location was bulbar in 48.1%, bulbopenile in 40.6%, and penile in 11.3% of cases. The mean stricture length was 5.28 cm, and the mean urethral plate width was 6.54 mm.

The mean overall operative time was 100.51 ± 16.60 min (median: 100; range: 60, 150 min), and mean postoperative hospital stay was 3.65 days (median: 3; range: 3, 8 days). Postoperative complications were reported in 45 patients (16.9%), and some patients had >1 complication. The reported complications were urethroplasty wound infection (n = 36; 13.5%), perineal hematoma (n = 14; 5.3%), epididymo-orchitis (n = 16; 6.0%), and urethral fistula (n = 1; 0.4%). All complications were treated conservatively. In the patient with urethral fistula, spontaneous fistula healing occurred after 1 month; however, redo surgery was performed after 6 months due to urethral restricture. Apart from early postoperative mild oral pain and transient swelling, no reported graft donor site complications. From the overall study cohort, 34 (12.8%) reported stricture recurrence, and 232 (87.2%) were not.

The demographics and clinicopathologic characteristics of the study cohort are summarized in Table 1. Patients who developed stricture recurrence experienced higher frequencies of obesity, inflammatory and iatrogenic etiologies, prior urethroplasty, and penile location of strictures. Also, the stricture was longer, and the urethral plate was wider in patients who developed stricture recurrence compared to those with the patent urethra ($p < 0.05$).

Cox regression analysis was performed to identify the predictors of urethral stricture recurrence (Table 2). All possible risk factors were analyzed using the univariate regression model. Obesity, inflammatory etiology, prior urethroplasty, penile location of stricture, and stricture length were the factors associated with stricture recurrence. However, multivariate analysis demonstrated that obesity (HR: 6.02; $p = 0.002$), inflammatory etiology (HR: 9.13; $p < 0.001$), prior urethroplasty (HR: 8.81; $p < 0.001$), penile location of the stricture (HR: 3.09; p = 033), and stricture length >4.5 cm (HR: 6.83; $p = 0.007$) were the independent predictors of stricture recurrence.

Downloaded by:
Seoul Nat'l Medical School
147.46.181.251 - 4/1/2021 7:28:19 AM

Color version available online

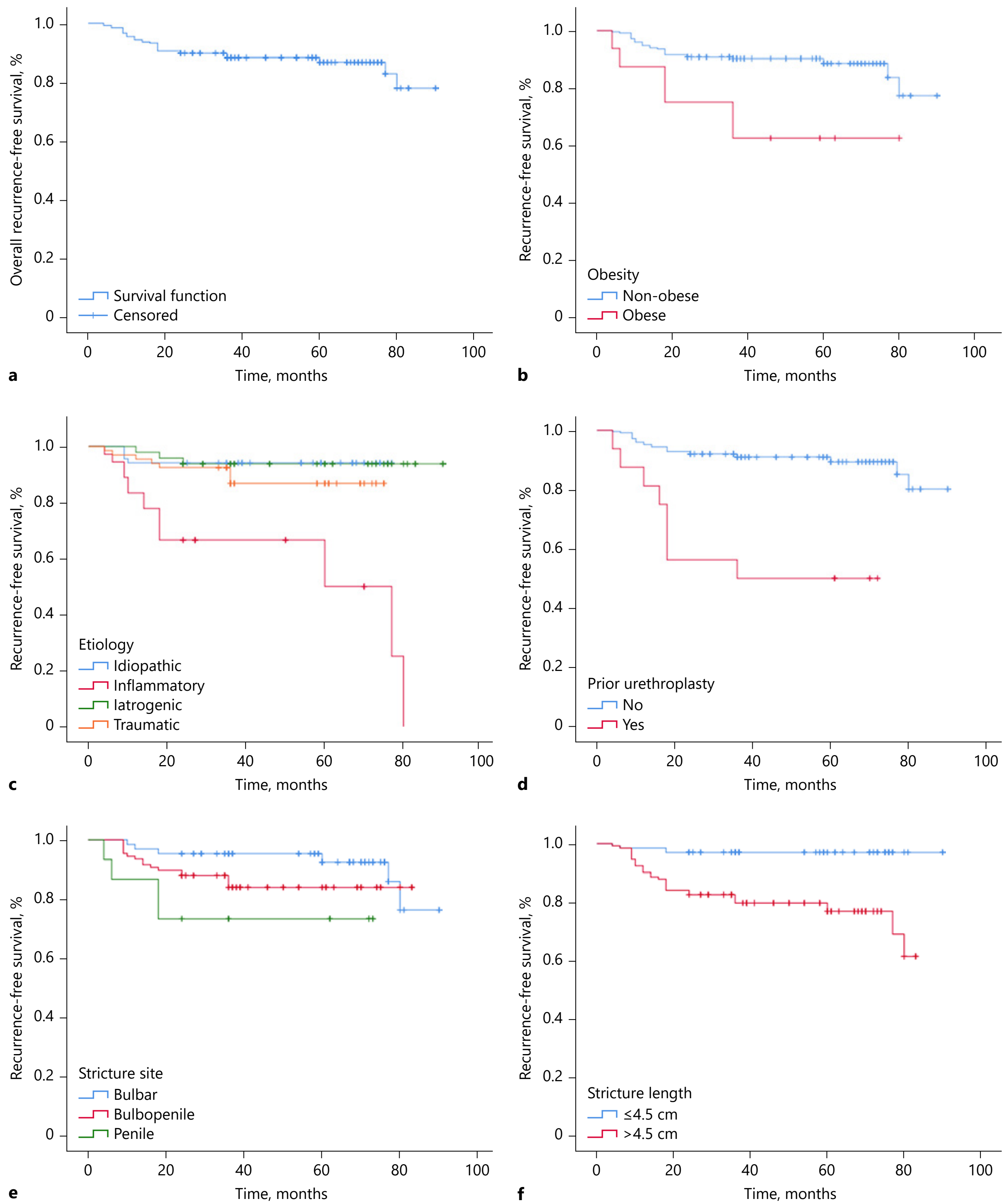

Fig. 1. Kaplan-Meier survival plot of recurrence-free survival. Overall (**a**), and stratified by the presence or absence of risk factors: obesity (**b**), stricture aetiology (**c**), prior urethroplasty (**d**), stricture site (**e**), and stricture length (**f**).

Downloaded by:
Seoul Nat'l Medical School
147.46.181.251 - 4/1/2021 7:28:19 AM

Table 3. Recurrence-free times according to the presence or absence of risk factors

	Mean stricture-free time, months	95% CI
Overall	79.93	76.74, 83.13
Obesity		
Yes	57.38	42.56, 72.19
No	80.87	77.61, 84.14
Stricture etiology		
Idiopathic	73.01	69.23, 76.80
Inflammatory	53.36	42.76, 63.97
Iatrogenic	85.50	82.00, 88.99
Traumatic	67.96	63.34, 72.58
Prior urethroplasty		
Yes	44.00	29.92, 58.08
No	81.73	78.69, 84.77
Stricture location		
Bulbar	83.75	80.04, 87.47
Bulbopenile	72.74	68.09, 77.39
Penile	56.60	46.79, 66.41
Stricture length		
>4.5 cm	68.15	63.42, 72.87
≤4.5 cm	87.66	85.39, 89.93

CI, confidence interval.

The recurrence-free survival overall and stratified by presence or absence of risk factors is demonstrated in Figure 1. The mean recurrence-free time was 79.93 months (95% CI: 76.74, 83.13 months). The mean time to recurrence was 21.59 months. The recurrence-free probability decreased with time; it was 94.4% after 1 year; 89.8% after 2 years, 88.4% after 3 years, 86.9% after 5 years, and 78.0% after 7 years. The restricture occurred in as early as 4 months and as late as 80 months postoperatively. Most of restricture (27 cases; 79.4%) occurred in the early postoperative 2 years. The mean recurrence-free survival times stratified by the presence or absence of risk factors are summarized in Table 3.

Discussion

The one-stage dorsal onlay urethroplasty using BMG has a high overall success rate, and it is considered an excellent treatment option for the most of long-segment anterior urethral strictures [7]. In the current series, the reported recurrence-free rate was 87.2% at an average follow-up period of 49.77 months. Barbagli and colleagues [15] reported an 80% recurrence-free rate after augmented BMG urethroplasty for isolated bulbar urethral stricture. Other series [14] found a higher success rate of 93.3%.

Similar to most of the previous studies [14, 17–20], we reported most of the recurrences within the first postoperative 2 years, and after that, the recurrence rate slowly increased with time. The probabilities of high recurrence rate in early postoperative years may be due to technical factors and wound infection that leads to poor graft take. In the current series, 79% of recurrences occurred in the first 2 years after surgery, and the recurrence was reported as late as 7 years postoperative. These findings indicate that stricture recurrence may occur at any time after surgery. This may be related to the underlying pathological process of biological factors that affect the stability of urethral reconstruction and graft with time. The recurrence-free probability is not unique in all studies. The difference between studies may be related to the study population, stricture characteristics, surgeons' experience, and the period of follow-up. Han et al. [18] reported a decreased recurrence-free rate after urethroplasty with an increased period of follow-up and found that >48-month follow-up was an independent predictor of stricture recurrence.

There is a discrepancy in the literature in determining which factors will be associated with stricture recurrence after urethroplasty. In the present series, we found that obesity, inflammatory etiology, prior urethroplasty, penile location of stricture, and stricture length were the significant independent predictors for stricture recurrence.

As most of the urethral strictures are diagnosed in older patients [1], it is important to evaluate the effect of aging on urethroplasty outcome. The age of patients in our study sample is younger than previously reported in other studies [17, 21]. This may be related to the difference in stricture etiology between studies. Similar to most of the previously reported results [17, 22–24], we did not find a significant association between age and urethroplasty outcome. In 128 urethroplasties performed on men >37 years, 14.1% reported a stricture recurrence compared to 11.6% in men ≤37 years. In contrast, Spilotros et al. [21] found a significant association between age and outcome after various forms of BMG urethroplasty. They observed better stricture treatment outcomes in patients <30 years with a recurrence rate of 6.3% compared to 15.2% in patients of 31–50 years and 35.1% in patients >50 years.

Some previous literature reported obesity [25, 26], diabetes mellitus (DM) [17, 19, 27], overall comorbidities [14], and smoking [28] as predictors of stricture recur-

Downloaded by:
Seoul Nat'l Medical School
147.46.181.251 - 4/1/2021 7:28:19 AM

rence after urethroplasty. In the present series, we found that obesity was associated with urethral stricture recurrence while smoking, DM, and overall comorbidities were not. Privratsky et al. [25] reported an increased failure rate after BMG urethroplasty in patients with a BMI above 35 kg/m^2. Ekerhult et al. [29] demonstrated that BMI >30 kg/m^2 was a predictor of stricture recurrence after one-stage penile urethroplasty, but not after the two-stage technique. Breyer et al. [26] reported the results depending on the BMI scale. In overweight and obese patients (BMI: 25–35 kg/m^2), there was an increased risk of recurrence. But, in patients with severe or morbid obesity (BMI >35 kg/m^2), there was no increased risk of recurrence. In contrast to most of the previous studies, Rapp et al. [30] demonstrated that BMI was not a significant predictor of stricture recurrence in univariate or multivariate analysis. In the present series, the obese patients showed a higher and earlier recurrence than nonobese ones. The association of obesity with stricture recurrence may be related to technical difficulties as obesity may impair surgical exposure, especially during the bulbar urethroplasty. Also, comorbidities associated with obesity that affect the wound healing process may be contributing factors.

DM may contribute to wound infection and delayed healing and increase the risk of stricture recurrence. Kinnaird et al. [17] reported the association of DM with urethroplasty failure. Another series [27] found that DM was a predictor of failure, and diabetic patients may be more likely to require additional procedures after the BMG bulbar urethroplasty. On the other hand, Chapman et al. [14] demonstrated that overall comorbidities were associated with failure, while individual ones were not.

In contrast to most of the previous studies, we did not find DM to be a risk predictor of stricture recurrence. The actual explanation is unknown. Generally, the development of diabetes-related wound complications is significantly affected by glycemic control [31]. Perioperative management of blood glucose levels can have a significant impact on the incidence of wound complications and, in turn, the stricture recurrence.

The adverse vascular effect, as well as poor oral hygiene associated with smoking, may affect wound healing and graft quality. Sinha et al. [28] reported that smoking increases the risk of BMG urethroplasty failure. Similar to most of the previous studies [14, 17, 18], we did not find smoking as a risk predictor of urethral stricture recurrence. Irrespective of its association with stricture recurrence, smoking cessation at least 1 month before any surgery significantly decreases the postoperative wound and overall complications [32].

There is a major controversy on which stricture etiology affects the urethroplasty outcome. Similar to our findings, Chapman et al. [14] demonstrated that inflammatory stricture is an independent predictor of stricture recurrence. Similarly, Kinnaird et al. [17] found that inflammatory stricture etiology was a significant predictor of failure, and Lichen sclerosis is highly correlated with poor urethroplasty outcome. In contrast, Spilotros et al. [21] and Han et al. [18] did not find this association in multivariate analysis. In the present series, inflammatory strictures have a lower recurrence-free probability, and restructure rate increased with time till the end of follow-up. This may be due to the presence of unhealthy tissue in the surgical bed with increased fibrosis, which makes the surgery difficult and leads to ischemia and poor graft take.

Several studies [14, 19, 33] reported that previous urethroplasty or endoscopic procedures (direct visual internal urethrotomy or dilatation) are independent predictors of stricture recurrence. In the present series, most of the patients had undergone previous endoscopic treatment, and this did not affect the outcome. These findings suggest that endoscopic intervention can be carried out as a temporary treatment without adverse effects on the definitive urethroplasty. Prior urethroplasty was found to be a significant predictor of stricture recurrence and have a lower recurrence-free probability. In contrast, several other series [14, 34] found that previous urethral interventions have no adverse effect on the urethroplasty outcome. We believe that the higher risk of stricture recurrence in patients with a prior history of urethral construction may be attributed to the extensive fibrosis and ischemia in the stricture area that may insult the urethroplasty procedure.

The fourth identifiable risk factor for stricture recurrence is the penile location of stricture. We reported a lower recurrence-free probability in patients with penile stricture, and all restrictures occurred in the first postoperative 2 years. The higher recurrence rate of penile stricture has been reported in several other studies. Spilotros et al. [21] reported a recurrence rate of 25.8% for penile stricture compared to 12.1% for bulbar stricture, and penile stricture site was the only independent factor for recurrence. Also, Wang et al. [35] reported recurrence rates in bulbar and penile urethroplasty of 12.6 and 22.4%, respectively. In contrast, several other series [15, 17, 18] reported that stricture location was not a significant predicting factor for stricture recurrence. In general, penile urethroplasty is usually a challenging procedure, and the risk of ischemia, infection, fistula formation, and re-stric-

Urol Int 2021;105:269–277
DOI: 10.1159/000512065

Downloaded by:
Seoul Nat'l Medical School
147.46.181.251 - 4/1/2021 7:28:19 AM

ture is high. These poor results may be related to the relatively poor blood supply of distal penile urethra and the greater stretchability of the graft with penile erections which jeopardized the graft take.

Similar to most of the previous studies [14, 17, 19, 36], we found that longer stricture was a significant predictor of stricture recurrence. The used cutoff point for the definition of longer stricture was >4 cm in Breyer et al. [19] study, ≥5 cm in Kinnaird et al. [17] study, and >3 cm in Gimbernat et al. [36] study. In the present series, we choose a cutoff point of 4.5 cm, depending on the median stricture length in our study sample, and found that >4.5 cm length was a significant predictor for stricture recurrence. The recurrence-free probability gradually decreased with time until the end of the study. This finding typically concerning BMG urethroplasty as long stricture will need a long graft. So, the surface area waiting for taking and blood supply is longer, and the probability of ischemic contracture is high. This factor is the most agreed one between several studies, which reported the same conclusion.

In the present series, we studied a new factor that expected to affect the outcome of dorsal onlay graft urethroplasty. We hypothesized that a narrow urethral plate might adversely affect the outcome. Although this factor was not associated with stricture recurrence in multivariate analysis, we found that the urethral plate was significantly wider in patients who developed stricture recurrence. Also, the wider urethral plate is associated with stricture recurrence in univariate analysis. The cause of these unexpected results is unclear. Undoubtedly, the used method for urethral plate width measurement could be inaccurate and unfair, especially in cases with irregular urethral narrowing. However, the association of wider urethral plate with stricture recurrence may be related to the primary pathology of stricture that progressively affects the urethral plate and, in turn, affects the stability of reconstructed urethra with time. A further prospective study on a large number of patients is recommended to evaluate this interesting point. Despite the prospectively planned scheduled postoperative investigation and follow-up with adequate data recording, the current study has its shortcomings. The method used to identify the urethral stricture recurrence in the late postoperative period may have limited the ability to detect some cases. Also, all urethroplasty procedures were performed at single tertiary care university hospital by an expert/subspecialized urologist. Therefore, the result may not be generalizable to lower volume surgeons.

Conclusions

Treatment of anterior urethral stricture with dorsal onlay BMG urethroplasty technique has a reasonable recurrence-free rate and acceptable postoperative complications. Obesity, inflammatory etiology, previous urethroplasty, penile location of stricture, and longer stricture were found to be the significant independent predictors of stricture recurrence. These factors should be taken into consideration and should be counseled when choosing the dorsal onlay augmented BMG urethroplasty technique for anterior urethral stricture.

Statement of Ethics

This study protocol was approved by the Research Ethics Committee of the Urology Department, Al-Azhar University, Cairo, Egypt (Reference Number: Uro_Azhar_4_020). All procedures performed in the present study involving human participants were in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Conflict of Interest Statement

The authors declare that they have no conflicts of interest.

Funding Sources

The authors did not receive any funding.

Author Contributions

O.S.: protocol development, data collection; H.A.: data collection, manuscript writing; A.E., protocol development, data collection; A.S., data collection; M.A., data collection; I.T., data collection; M.H., data collection; A.K., data collection; M.F., protocol development; and A.-F.A: data collection, data analysis, and manuscript writing. They all approved the final version of the manuscript.

References

1 Santucci RA, Joyce GF, Wise M. Male urethral stricture disease. J Urol. 2007;177(5):1667–74.
2 Rourke K, Hickle J. The clinical spectrum of the presenting signs and symptoms of anterior urethral stricture: detailed analysis of a single institutional cohort. Urology. 2012;79(5):1163–7.
3 Rourke KF, Jordan GH. Primary urethral reconstruction: the cost minimized approach to the bulbous urethral stricture. J Urol. 2005;173(4):1206–10.

Downloaded by:
Seoul Nat'l Medical School
147.46.181.251 - 4/1/2021 7:28:19 AM

4 Burks FN, Santucci RA. Complicated urethroplasty: a guide for surgeons. Nat Rev Urol. 2010;7(9):521.
5 Barbagli G, Selli C, Tosto A, Palminteri E. Dorsal free graft urethroplasty. J Urol. 1996;155(1):123–6.
6 Chapple C, Andrich D, Atala A, Barbagli G, Cavalcanti A, Kulkarni S, et al. SIU/ICUD consultation on urethral strictures: the management of anterior urethral stricture disease using substitution urethroplasty. Urology. 2014;83(3 Suppl):S31–47.
7 Shalkamy OA, Abdelrahim AF, Elmikkawy SA, Mourad MM, Eleweedy SM. Long-term outcomes of single stage dorsal onlay buccal mucosa urethroplasty for different anterior urethral strictures: a prospective study. Urol Nephrol Open Access J. 2017;5(5):00188.
8 Mangera A, Patterson JM, Chapple CR. A systematic review of graft augmentation urethroplasty techniques for the treatment of anterior urethral strictures. Eur Urol. 2011;59(5):797–814.
9 Soave A, Steurer S, Dahlem R, Rink M, Reiss P, Fisch M, et al. Histopathological characteristics of buccal mucosa transplants in humans after engraftment to the urethra: a prospective study. J Urol. 2014;192(6):1725–9.
10 Soave A, Kluth L, Dahlem R, Rohwer A, Rink M, Reiss P, et al. Outcome of buccal mucosa graft urethroplasty: a detailed analysis of success, morbidity and quality of life in a contemporary patient cohort at a referral center. BMC Urol. 2019;19(1):18.
11 Ahyai SA, Schmid M, Kuhl M, Kluth LA, Soave A, Riechardt S, et al. Outcomes of ventral onlay buccal mucosa graft urethroplasty in patients after radiotherapy. J Urol. 2015;194(2):441–6.
12 Marshall SD, Raup VT, Brandes SB. Dorsal inlay buccal mucosal graft (Asopa) urethroplasty for anterior urethral stricture. Transl Androl Urol. 2015;4(1):10.
13 Pfalzgraf D, Kluth L, Isbarn H, Reiss P, Riechardt S, Fisch M, et al. The Barbagli technique: 3-year experience with a modified approach. BJU Int. 2013;111(3b):E132–6.
14 Chapman D, Kinnaird A, Rourke K. Independent predictors of stricture recurrence following urethroplasty for isolated bulbar urethral strictures. J Urol. 2017;198(5):1107–12.
15 Barbagli G, Kulkarni SB, Fossati N, Larcher A, Sansalone S, Guazzoni G, et al. Long-term followup and deterioration rate of anterior substitution urethroplasty. J Urol. 2014;192(3):808–13.
16 Barbagli G, Selli C, Di Cello V, Mottola A. A one-stage dorsal free-graft urethroplasty for bulbar urethral strictures. Br J Urol. 1996;78(6):929–32.
17 Kinnaird AS, Levine MA, Ambati D, Zorn JD, Rourke KF. Stricture length and etiology as preoperative independent predictors of recurrence after urethroplasty: a multivariate analysis of 604 urethroplasties. Can Urol Assoc J. 2014;8(5–6):E296.
18 Han JS, Liu J, Hofer MD, Fuchs A, Chi A, Stein D, et al. Risk of urethral stricture recurrence increases over time after urethroplasty. Int J Urol. 2015;22(7):695–9.
19 Breyer BN, McAninch JW, Whitson JM, Eisenberg ML, Mehdizadeh JF, Myers JB, et al. Multivariate analysis of risk factors for long-term urethroplasty outcome. J Urol. 2010;183(2):613–7.
20 Liu JS, Dong C, Gonzalez CM. Risk factors and timing of early stricture recurrence after urethroplasty. Urology. 2016;95:202–7.
21 Spilotros M, Sihra N, Malde S, Pakzad MH, Hamid R, Ockrim JL, et al. Buccal mucosal graft urethroplasty in men: risk factors for recurrence and complications: a third referral centre experience in anterior urethroplasty using buccal mucosal graft. Transl Androl Urol. 2017;6(3):510.
22 Santucci RA, McAninch JW, Mario LA, Rajpurkar A, Chopra AK, Miller KS, et al. Urethroplasty in patients older than 65 years: indications, results, outcomes and suggested treatment modifications. J Urol. 2004;172(1):201–3.
23 Barbagli G, De Angelis M, Romano G, Lazzeri M. Long-term follow-up of bulbar end-to-end anastomosis: a retrospective analysis of 153 patients in a single center experience. J Urol. 2007;178(6):2470–3.
24 Kulkarni S, Barbagli G, Sansalone S, Lazzeri M. One-sided anterior urethroplasty: a new dorsal onlay graft technique. BJU Int. 2009;104(8):1150–5.
25 Privratsky JR, Almassi N, Guralnick ML, Anderson BJ, O'Connor RC. Outcomes of grafted bulbar urethroplasty in men with class II or III obesity. Urology. 2011;78(6):1420–3.
26 Breyer BN, McAninch JW, Whitson JM, Eisenberg ML, Master VA, Voelzke BB, et al. Effect of obesity on urethroplasty outcome. Urology. 2009;73(6):1352–5.
27 Figler BD, Malaeb BS, Dy GW, Voelzke BB, Wessells H. Impact of graft position on failure of single-stage bulbar urethroplasties with buccal mucosa graft. Urology. 2013;82(5):1166–70.
28 Sinha RJ, Singh V, Sankhwar SN. Does tobacco consumption influence outcome of oral mucosa graft urethroplasty? Urol J. 2010;7(1):45–50.
29 Ekerhult TO, Lindqvist K, Peeker R, Grenabo L. Limited experience, high body mass index and previous urethral surgery are risk factors for failure in open urethroplasty due to penile strictures. Scand J Urol. 2015;49(5):415–8.
30 Rapp DE, Mills JT, Smith-Harrison LI, Smith RP, Costabile RA. Effect of body mass index on recurrence following urethroplasty. Transl Androl Urol. 2018;7(4):673.
31 Rosenberg CS. Wound healing in the patient with diabetes mellitus. Nurs Clin North Am. 1990;25(1):247–61.
32 Mills E, Eyawo O, Lockhart I, Kelly S, Wu P, Ebbert JO. Smoking cessation reduces postoperative complications: a systematic review and meta-analysis. Am J Med. 2011;124(2):144–154.e8.
33 Kessler TM, Schreiter F, Kralidis G, Heitz M, Olianas R, Fisch M. Long-term results of surgery for urethral stricture: a statistical analysis. J Urol. 2003;170(3):840–4.
34 Barbagli G, Palminteri E, Lazzeri M, Guazzoni G, Turini D. Long-term outcome of urethroplasty after failed urethrotomy versus primary repair. J Urol. 2001;165(6 Pt 1):1918–9.
35 Wang K, Miao X, Wang L, Li H. Dorsal onlay versus ventral onlay urethroplasty for anterior urethral stricture: a meta-analysis. Urol Int. 2009;83(3):342–8.
36 Gimbernat H, Arance I, Redondo C, Meilán E, Ramón de Fata F, Angulo JC. Analysis of the factors involved in the failure of urethroplasty in men. Actas Urol Esp. 2014;38(2):96–102.

Downloaded by:
Seoul Nat'l Medical School
147.46.181.251 - 4/1/2021 7:28:19 AM