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ORIGINAL PAPER

Ten years' single surgeon experience of excision and primary anastomosis (EPA) urethroplasty for traumatic urethral stricture: An analysis of risk factors for urethral stricture recurrence

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Summary

***Introduction:** Excision and Primary Anastomosis (EPA) urethroplasty is the standard treatment for traumatic urethral strictures, but managing them remains challenging for urologists. Identifying factors leading to EPA urethroplasty failure benefits both patients and surgeons. This study aims to analyze risk factors for urethral stricture recurrence after one-year follow-up of EPA urethroplasty.*

***Materials and methods:** Data on male patients undergoing EPA urethroplasty at the Urology Department of Saiful Anwar General Hospital from January 2013 until December 2023 were prospectively recorded. Successful urethroplasty, defined as the absence of additional treatment necessity, was assessed until 12 months follow-up. Demographic data, time to surgery, stricture etiology, comorbidities, prior urethral interventions, and operation steps were recorded. Univariate and multivariate cox-regression analyses were performed using IBM SPSS Statistics version 21.*

***Result:** Total 95 patients were observed, and 89 patients were included, averaging 41.2 ± 15.59 years old. EPA urethroplasty succeeded in 91% of cases over a median follow-up of 16.3 months. Pelvic fracture urethral injury (PFUI) was the predominant etiology in 74% of cases, with an average stricture length of 25.4 ± 16.3 mm. The average time to surgery was performed on average 6.67 ± 4.07 months after diagnosis. In univariate analysis, body mass index (BMI), time to surgery, and stricture length were associated with urethral stricture recurrence. However, only time to surgery showed a significant association in multivariate analysis.*

***Conclusions:** Obesity, the length of the stricture, and delayed surgical intervention are associated with an increased risk of urethral stricture recurrence in patients following EPA. EPA urethroplasty demonstrates a high success rate in managing traumatic urethral strictures.*

KEY WORDS: *Urethral stricture; EPA urethroplasty; Prognosis; Risk factors.*

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INTRODUCTION

Excision and Primary Anastomosis (EPA) urethroplasty is recognized as a gold standard surgical technique for the management of traumatic urethral strictures, particularly in cases involving the bulbar urethra. Traumatic urethral strictures are a significant clinical challenge, often resulting from various forms of trauma, particularly in males. The etiology of these strictures is multifaceted, with trauma being a predominant cause. Various mechanisms of injury contribute to the development of urethral strictures, including pelvic fractures, straddle injuries, and direct trauma to the urethra during accidents (1).

The incidence of motorcycle road accidents leading to pelvic fractures and urethral injury in Indonesia is a significant public health issue, exacerbated by the country's high reliance on motorcycles as a primary mode of transportation (2). The prevalence of this condition varies, with estimates suggesting that it affects 229 to 627 individuals per 100,000, and can be particularly pronounced in certain demographics (3, 4). The management of these strictures has evolved, with EPA urethroplasty being favored for its high success rates and low complication profiles, particularly for strictures shorter than 2 cm (5-7).

The technique of EPA urethroplasty involves the excision of the diseased segment of the urethra followed by direct end-to-end anastomosis. This method is particularly effective for short, isolated bulbar strictures, yielding success rates upwards of 90% (5, 6, 8). However, the risk of recurrence remains a significant concern in the management of urethral strictures post-trauma. Factors influencing recurrence include the length of the stricture, the presence of underlying conditions, and the surgical technique employed (8-11). Identifying factors leading to EPA urethroplasty failure benefits both patients and surgeons. This study aims to analyze risk factors for urethral stricture recurrence after one-year follow-up of EPA urethroplasty.

METHODS

Pre operative patients assessment

We conducted a retrospective analysis of the medical records of 95 male patients diagnosed with traumatic urethral stricture who were referred from nearby hospital and all across Indonesia. We reviewed demographic details, educational status, underlying causes, comorbidities, smoking history, previous procedures, as well as the duration of the disease, interventions, and outcomes based on both inpatient and outpatient records. Patients were classified as highly educated if they had completed an undergraduate degree. All patients underwent EPA urethroplasty performed by a single surgeon (PS) at *Saiful Anwar General Hospital in Malang, Indonesia*, between January 2013 and December 2023. Patients with penile strictures, a history of hypospadias, or those requiring tissue substitution techniques were excluded from this study. The duration of the disease was defined as the time elapsed from the initial diagnosis of the urethral stricture to the date of the EPA procedure. Each patient had a suprapubic catheter placed to allow for urethral rest. To assess the location and length of the stricture, a *Bipolar Voiding Cysto-Urethrography* (BVCUG) was performed.

Surgical technique

All patients underwent EPA urethroplasty under general anesthesia while positioned in the lithotomy position via the perineal approach. After mobilizing the bulbar urethra, the stricture location was identified intraoperatively using rigid cystoscopy, and the urethra was transected at the stricture site with sharp scissors. The scar tissue at both urethral ends was then completely excised until healthy urethral mucosa was reached. A wide-caliber, spatulated, tension-free anastomosis was performed using six 4-0 PGA sutures. EPA urethroplasty consists of several adjunctive surgical steps to achieve a tension-free anastomosis, including bulbar mobilization, crural separation, inferior pubectomy, supracrural rerouting, and total pubectomy, particularly when the stricture is too long for a tension-free anastomosis. Finally, a 14Fr silicone Foley catheter was inserted, which remained in place for four weeks postoperatively. If the procedure for EPA urethroplasty consists only in bulbar mobilization, this was classified as bulbar mobilization. On the contrary, if the procedure includes steps beyond bulbar mobilization, it was categorized as over bulbar mobilization.

Postoperative follow-up and outcome definition

Patients were followed up at 1, 3, and 12 months after surgery, and then annually, with evaluations including uroflowmetry and residual urine volume measurements. Urethrography was conducted whenever a recurrent stricture was suspected, indicated by a decrease in urinary flow rate and/or worsening symptoms. Successful urethroplasty was defined as the absence of the need for further treatment. Paired T-Test was used to assessed patient outcome parameters. Both univariate and multivariate Cox regression analyses were conducted using IBM SPSS Statistics version 21. P values < 0.05 were considered statistically significant.

Results

A total of 95 patients were observed, and 89 were included in the study, with an average age of 41.2 ± 15.59 years. The patients had a mean *body mass index* (BMI) of 23.05 kg/m². Hypertension and *diabetes mellitus* (DM) were present as comorbidities in 10.1% and 16.9% of the patients, respectively. The most common aetiology of urethral strictures was *pelvic fracture urethral injury* (PFUI), followed by straddle injury, iatrogenic causes related to transurethral surgery, and direct trauma. The bulbo-membranous urethra had the highest incidence of strictures, followed by the bulbar urethra. More than 35% of patients had undergone endoscopic treatment 1-2 times previously, while about 39% had never received endoscopic treatment. The average time to surgery was performed on average 6.67 ± 4.07 months after diagnosis. EPA urethroplasty was successful in 91% of cases, with a median follow-up of 16.3 months. Eight patients reported had recurrent stricture, two patients at 3 months after the surgery and six patients at 12 months after the surgery. For recurrent strictures, treatments included redo EPA urethroplasty in 3 cases, urethral dilatation in 4 cases, and redo non-transecting urethroplasty in 1 case (Table 1).

The uroflowmetry outcomes from 1 month, 3 months and 12 months after the surgery of the patient did not show any different such as Q_{max}, Voided Volume and *post void residual volume* (PVR) (Table 2, Figure 1). In univariate analysis, *body mass index* (BMI) (OR 4.45, 95%CI

Table 1.
Patient characteristics.

Number of patient	89	
Age (year) (SD)	41.24	(± 15.59)
Median follow-up (months) (SD)	16.3	(± 3.15)
BMI (kg/m^2), mean (SD)	23.05	(± 2.57)
Highly educated, n (%)	23	(25.8)
Current smoker, n (%)	26	(29.2)
DM Type 2, n (%)	9	(10.1)
Hypertension, n (%)	15	(16.9)
Stricture length (mm), mean (SD)	25.4	(± 16.3)
Time to surgery (month), mean (SD)	6.67	(± 4.07)
Stricture aetiology, n (%)		
Straddle injury	11	(12.35)
Iatrogenic	10	(11.23)
Direct	2	(2.24)
PFUI	66	(74.15)
Stricture site, n (%)		
Bulbar	27	(30.34)
Bulbo-membranous	62	(69.66)
Previous endoscopic treatment, n (%)		
0	28	(31.46)
1-2	32	(35.95)
> 2	29	(32.58)
Surgical steps, n(%)		
Bulbar mobilization	35	(39.33)
Crural separation	29	(32.58)
Inferior pubectomy	24	(26.96)
Supracrural rerouting	1	(1.12)
EPA Outcome, n (%)		
Success	81	(91)
Recurrance	8	(9.00)
Recurrence operative treatement		
Redo EPA urethroplasty	3	(37.5)
Redo non-transecting urethroplasty	1	(12.5)
Urethral dilatation	4	(50)

BMI: Body Mass Index; DM: Diabetes Mellitus; SD: Standard Deviation; EPA: Excision Primary Anastomosis; PFUI: Pelvic Fracture Urethral Injury.

1.36-28.1, p = 0.007), time to surgery (OR 3.89, 95%CI 1.63-13.24, p = 0.003), and stricture length (OR 2.14, 95%CI 1.05-1.62, p = 0.01) were associated with urethral stricture recurrence. However, only time to surgery (OR 2.44, 95%CI 1.06-12,93, p = 0.04) showed a significant association in multivariate analysis (Table 3).

	1 Month (n: 89)	3 Months (n: 87)		12 Months (n: 81)		
	Mean ± SD	Mean ± SD	p value* (vs 1 month)	Mean ± SD	p value * (vs 1 month)	p value * (vs 3 Months)
Q_{max} (mL/s)	20.63 ± 3.47	20.18 ± 3.69	0.14	20.95 ± 3.39	0.17	0.4
Voided volume (mL/s)	139.8 ± 15.47	137.75 ± 18.28	0.12	140.58 ± 17.12	0.73	0.52
PVR (mL/s)	29.47 ± 5.09	31.78 ± 8.87	0.73	30.31 ± 8.25	0.87	0.67

* Includes only patients who were able to void (n: 81). Q_{max}: maximum flow rate; PVR: postvoid residual; SD: Standard Deviation.

Table 2.
Uroflowmetry outcomes.

	Univariate analysis			Multivariate analysis		
	OR	95% CI	p value	OR	95% CI	p value
Age ≤ 60 *vs* > 60	1.25	0.16-6.78	0.55			
Education Low *vs* High		3.56	1.26-4.56	0.15		
BMI ≤ 25 *vs* > 25	4.45	1.36-28.1	0.007 *	2.40	0.96-22.7	0.49
Current smoker	1.89	0.30-8.14	0.12			
DM type 2	6.34	0.41-20.85	0.07			
Hypertension	3.52	1.38-29.23	0.09			
Time to surgery ≤ 6 months *vs* > 6 months	3.89	1.63-13.24	0.003 *	2.44	1.06-12,93	0.04 *
Stricture Length ≤ 20 mm *vs* > 20 mm	2.14	1.05–1.62	0.01 *	0.08	0.98–2.17	0.35
Stricture Side Bulbo-membranous *vs* bulbar	1.26	0.30-5.14	0.12			
Previous endoscopic treatment Yes *vs* no	1.63	0.37-6.06	0.48			
Type of Injury Non PFUI *vs* PFUI	1.83	0.27-8.349	0.29			
Surgical steps Bulbar mobilization *vs* over bulbar mobilization	1.5	0.19-7.93	0.43			

* Significant result. BMI: Body Mass Index; CI: Confidence Interval; DM: Diabetes Mellitus; OR: Odd Ratio; PFUI: Pelvic Fracture Urethral Injury.

Table 3.
Uni- and multivariate Cox regression analysis for risk factor recurrence rate EPA urethroplasty.

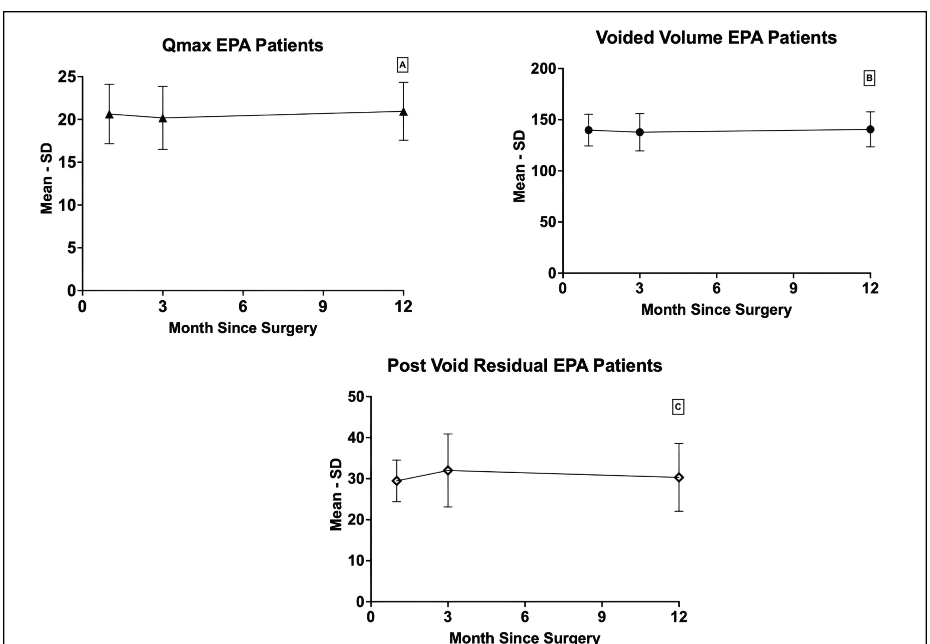

Figure 1.
Changes in Q_{max} (A), Voided volume (B), Post void residual (C) from 1, 3, and 12 months.

Discussion

EPA urethroplasty is widely regarded as the gold standard for treating traumatic urethral strictures, particularly those caused by pelvic fractures or direct trauma. In Indonesia, motorcycle accidents often result in pelvic fractures and associated urethral injuries (2). This finding is consistent with our cohort, where PFUI accounted for 74% of the causes of traumatic urethral strictures. Our cohort achieved a high success rate of 91% in EPA urethroplasty, comprising 89 patients, making it one of the largest series of patients undergoing this procedure in Southeast Asia, despite the relatively short follow-up period (median of 16.3 months). This outcome is consistent with previous studies that report success rates ranging from 85% to 95% (12). However, the definition of a successful urethroplasty remains a topic of debate, with no clear agreement on the best postoperative follow-up approach. In our study, successful urethroplasty was defined as the absence of the need for further treatment, which has been widely used in most previous research (13). At our center, postoperative follow-up typically involves catheter removal four weeks after surgery, followed by uroflowmetry. We do not routinely perform postoperative cystoscopy due to the unavailability of flexible cystoscopy, as well as concerns about cost-effectiveness and the geographical burden, which requires patients to travel to our center. Despite this positive result, the potential for stricture recurrence remains a concern, with various factors influencing the risk of recurrence.

One of the primary risk factors identified in the literature is the length of the stricture. Studies have shown that longer strictures, particularly those exceeding 2 cm, are associated with higher recurrence rates following urethroplasty (14, 15). This is likely due to the increased complexity of surgical repair and the potential for inadequate vascularization of the anastomosed segment. Furthermore, the presence of dense periurethral fibrosis, often seen in long strictures, can complicate the surgical approach and contribute to poorer outcomes (16). In our cohort, strictures longer than 2 cm were associated with a greater risk of recurrence. Two patients experienced recurrence within the first 3 months, and six within 12 months after surgery. This is in line with the findings of *Kinnaird et al.*, who reported an average recurrence time of 11.7 months, with occurrences ranging from 2 weeks to 77 months (17). Similarly, *Barbagli et al.*, observed that recurrences in their cohort of both anastomotic and substitution urethroplasty patients were evenly distributed over time, with a plateau reached only after 5 years (18).

BMI has been identified as a potential risk factor influencing the recurrence of urethral strictures following EPA urethroplasty. The relationship between BMI and surgical outcomes is multifaceted, as obesity can impact both the surgical procedure and the healing process (19). In our cohort, patients with BMI over 25 significantly had higher risk of recurrence. the technical challenges posed by a higher BMI can complicate the surgical approach. Increased adipose tissue in the perineal region may hinder access to the urethra, making it more difficult to achieve a tension-free anastomosis, which is crucial for successful outcomes (20). Additionally, the presence of excess tissue may lead to increased tension at the anastomosis site, further contributing to the risk of recurrence (21).

One notable finding from this cohort is that delayed surgical intervention exceeding 6 months is a significant predictor of recurrence in patients undergoing EPA urethroplasty. As we know, Indonesia is one of the largest archipelagic countries in the world, comprising numerous islands, which makes accessing adequate healthcare facilities time-consuming and costly (22). Furthermore, the limited distribution of reconstructive urologists is a major factor contributing to the prolonged time before patients receive treatment. This correlation underscores the importance of prompt evaluation and management of urethral strictures, as timely surgical intervention is linked to better healing conditions and outcomes (23).

Comorbidities such as DM and hypertension have been shown to influence stricture recurrence in some studies. These conditions may predispose patients to recurrence due to poor microvascular circulation and impaired wound healing associated with DM and hypertension (24). However, this finding contrasts with the results of our cohort study, where DM and hypertension were not statistically significant risk factors for recurrence. We believe this discrepancy may be attributed to the relatively young average age of patients undergoing EPA urethroplasty in our study, which was 41.2 years, at an age when few individuals have developed degenerative diseases.

The location of the stricture is another critical factor. A study by *Bagchi et al.* identified the bulbar urethra as the most common site of stricture, which is generally associated with better outcomes compared to membranous urethral strictures, where recurrence rates tend to be higher due to the complexity of the anatomical region and the proximity to the external urinary sphincter (7). In our cohort, the bulbomembranous urethra exhibited the highest incidence of strictures; however, there was no significant difference in recurrence risk based on the location of the stricture. Several studies indicate that prior urethral procedures can impact outcomes. These patients tend to have a slightly higher incidence of recurrence, likely due to the cumulative trauma resulting from previous dilatations or urethrotomies (12, 18). In our cohort, over 35% of patients had undergone one or more endoscopic treatments before opting for EPA urethroplasty; however, interestingly, this finding does not align with the results of our study.

Limitations of the present study include its retrospective nature, limited follow-up duration, single institution and surgeon, relatively small sample size, and subjectivity in outcome assessment. While our criteria for defining recurrence were somewhat subjective and relied on patient-reported symptoms that prompted urethrography, we believe this approach is clinically valid due to the lack of consensus on how to define stricture recurrence following urethroplasty. Addressing these limitations through larger, multicenter, and prospective studies will be essential for optimizing surgical techniques and improving patient outcomes.

Conclusions

Obesity, the length of the stricture, and delayed surgical intervention are associated with an increased risk of urethral stricture recurrence in patients following EPA. EPA urethroplasty demonstrates a high success rate in managing traumatic urethral strictures. Careful patient selection, along with prompt and appropriate surgical intervention, is crucial to improving long-term outcomes and reducing the risk of re-stricture.

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Declarations

Ethical approval: *This study was approved by the Health Research Ethics Commission of Saiful Anwar General Hospital Number: 400/214/K.3/102.7/2024.*

Availability of data and material: *The datasets used and/or analyzed during the current study are available upon reasonable request.*

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