

Anatomical and Functional Outcome of Penile Skin Graft for Urethral Substitution in Long Segment Anterior Urethral Strictures Using One-sided Dorsal Perineal Approach: A Prospective Study

Mohamed A. Anwar ^{*}, Ahmed Alrefaey, Mostafa E. Abdelmagid, Ahmed Fahim

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

Abstract

Objectives: To assess the outcomes of penile skin graft (PSG) in repairing long anterior urethral strictures using a unilateral dorsal perineal approach.

Methods: This prospective study involved 31 patients diagnosed with long anterior urethral strictures (>2 cm) between June 2022 and July 2024. All patients underwent PSG urethroplasty and were followed for 12 months. The primary endpoint was urethral patency at 12 months, evaluated by retrograde urethrography (RUG). Secondary outcomes included improvements in lower urinary tract symptoms (LUTS), sexual function, and patient satisfaction, assessed through IPSS, IIEF-5, MSHQ-EJD, and satisfaction questionnaires. Success was defined as symptom improvement by 50%, a Q-max ≥ 10 mL/s, and no recurrent stricture on RUG.

Results: The mean age of the patients was 40.9 ± 14 years, with 22 (71.0%) having prior urethral interventions. The mean stricture length was 6.4 ± 2.3 cm, and the mean operative time was 115.6 ± 18.9 minutes. At 12 months, the success rate was 87.1% (95% CI: 70.2% – 96.4%). Significant improvements were noted in Q-max, IPSS, and patient satisfaction (all $p < 0.001$). No significant differences were observed in IIEF-5 ($p = 0.460$) and MSHQ-EJD scores ($p = 0.500$). Postoperative complications occurred in 2 patients (6.45%), both with urethrocutaneous fistulas.

Conclusion: PSG for long anterior urethral strictures demonstrates high success rates, significant improvement in urinary symptoms, preservation of sexual and ejaculatory functions, and a low incidence of complications.

Keywords: Anatomical outcome; Augmentation urethroplasty; Functional outcome; Penile skin graft; Urethral stricture

1. Introduction

Urethral stricture repair is influenced by several factors, including the location and length of the stricture, the extent of spongiofibrosis, and the underlying etiology. Urethroplasty, the surgical treatment for urethral strictures, can be classified into two main techniques: excision with primary anastomosis and augmentation urethroplasty. The direct anastomosis technique is typically reserved for short-segment strictures (≤ 2 cm), whereas longer strictures generally require substitution techniques.¹

Grafts or local skin flaps are commonly employed to substitute and augment the

urethra. While local skin flaps may offer outcomes comparable to grafts, they are associated with a higher risk of complications such as penile torsion, shrinkage, and tissue necrosis. Additionally, the mobilization of skin flaps can be technically demanding. For these reasons, grafts are often the preferred choice for urethral substitution when feasible.²

Several types of grafts have been utilized in urethral reconstruction, including genital and extra-genital skin, bladder mucosa, buccal mucosa, tunica vaginalis, colonic mucosa, lingual mucosa, and mesh grafts. Among these, buccal mucosal grafts (BMG) and penile skin grafts (PSG) are the most commonly used materials for urethral substitution.³

Accepted 15 April 2025.

Available online 30 June 2025

^{*} Corresponding author at: Urology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: islam.orth1592@gmail.com (M. A. Anwar).

<https://doi.org/10.21608/aimj.2025.446616>

2682-339X/© 2024 The author. Published by Al-Azhar University, Faculty of Medicine. This is an open access article under the CC BY-SA 4.0 license (<https://creativecommons.org/licenses/by-sa/4.0/>).

Currently, BMG is considered the gold standard for substitution urethroplasty due to its readily available, strong, and well-vascularized tissue, which resists infection. However, BMG harvesting can lead to complications such as oral fibrosis, perioral numbness, and difficulty opening the jaw. Furthermore, BMG harvesting is contraindicated in patients with oral morbidity (e.g., oral leukoplakia, poor oral hygiene, heavy smoking, prior perioral irradiation, or previous graft harvesting) or in those at high risk for general anesthesia.^{4,5}

PSG offers several potential advantages over BMG. These include the use of the same operative field, a shorter surgical duration, greater familiarity for urologists, the possibility of regional anesthesia, and the ability to use longer grafts when needed.⁶

Substitution urethroplasty techniques can be approached dorsally, ventrally, dorsolaterally, or laterally. In 2008, Barbagli and Kulkarni introduced a technique involving one-sided urethral mobilization while sparing the bulbospongiosus muscle, with the placement of BMG dorsolaterally to preserve the unilateral blood supply to the urethra and maintain the blood and nerve supply of the bulbospongiosus muscle.^{7,8}

While BMG is widely considered the gold standard for urethral substitution, the evidence supporting PSG, especially regarding its effectiveness, graft survival, and impact on sexual and urinary function, remains limited. In this study, we hypothesized that the use of PSG to substitute long-segment anterior urethral strictures, combined with unilateral urethral dissection, would provide a viable and effective option for reconstructive urologists.

Our primary objective was to assess the outcomes of PSG in terms of urethral patency and improvement in urinary and sexual function.

2. Patients and methods

This prospective interventional clinical study was conducted at the Department of Urology, Al-Azhar University, Cairo, Egypt, from June 2022 to July 2024. Ethical approval for the study was obtained from the institution's review board (Registration number: Uro-Surg./MD/2022/0011), and all participants provided informed written consent prior to enrollment.

Adult male patients (aged >18 years) with long anterior urethral strictures exceeding 2 cm in length were included in the study. Patients with urethral diverticulae, urethrocutaneous fistulae, lichen sclerosus, or an unsalvageable urethral

plate were excluded. A total of 31 patients were enrolled and underwent penile skin graft (PSG) augmentation urethroplasty. This sample size ensures 80% statistical power at an alpha error level of 0.05.

Preoperative assessment included both anatomical and functional evaluations. The anatomical evaluation was conducted using retrograde urethrography (RGU) and voiding cystourethrography (VCUG). Functional assessments included the evaluation of lower urinary tract symptoms (LUTS) through uroflowmetry and the International Prostate Symptom Score (IPSS). In sexually active patients, sexual function was assessed using the International Index of Erectile Function (IIEF)⁹ and the Male Sexual Health Questionnaire for Ejaculatory Dysfunction (MSHQ-EJD).¹⁰ Patient satisfaction was measured using a self-reported overall treatment satisfaction scale, ranging from "Delighted" to "Terrible."

Surgical technique

Surgical intervention was performed under general or spinal anesthesia with the patient positioned in the lithotomy position. A preoperative ureteroscopy was carried out to assess the stricture characteristics and evaluate lumen obliteration. A midline perineal incision was made, and unilateral urethral dissection was performed, preserving the bulbospongiosus muscle and the contralateral urethral blood supply (Figure 1).



Figure 1. Unilateral urethral dissection.

The PSG was harvested from the distal penile skin, just below the coronal sulcus, either in a transverse or longitudinal orientation (Figure 2a). The graft was then defatted and thinned to the dermal layer, placed in saline for preservation, and prepared for fixation (Figure 2b).

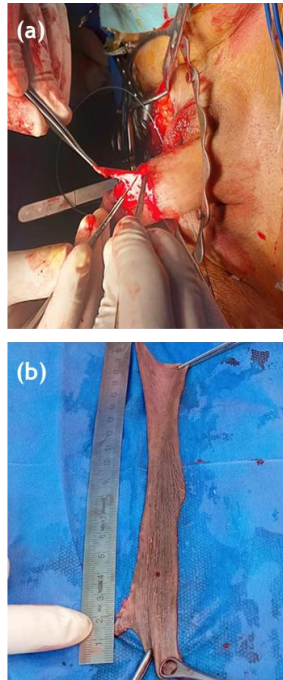


Figure 2. Penile skin graft harvesting.

Following urethral calibration, the stricture site and its length were confirmed. A dorsal urethrotomy was performed, and the graft was sutured to the corresponding corporal body using quilting sutures (Figure 3a,b), and then anastomosed to the medial urethral plate edge (Figure 3c). The lateral edges of the graft and urethral plate were anastomosed over a 16 Fr urethral catheter in a dorsal onlay fashion [Figure 3d]. A surgical drain was placed if necessary.

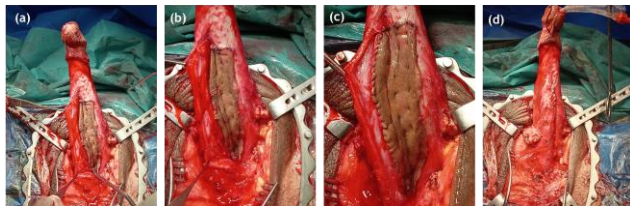


Figure 3. Stages of one-sided dorsolateral onlay urethroplasty.

Patients remained hospitalized until the surgical drain was removed. They received broad-spectrum intravenous antibiotics, which were converted to oral antibiotics after hospital discharge and continued for 4 weeks, until the urethral catheter was removed. Wound healing was evaluated during the first postoperative follow-up visit at 1 week. The urethral catheter was removed after 1 month, and retrograde urethrography was performed to assess the anatomical outcome.

Patients were followed up at 3-month intervals, with additional visits scheduled as needed, for a duration of one year. During follow-up visits, both anatomical and functional outcomes were assessed using the IPSS, QoL questionnaire, IIEF score, and MSHQ-EJD. RGU

and VCUG were performed at the 3-month and 1-year visits, as well as whenever clinically indicated.

The primary outcome was urethral patency at 12 months, assessed by RUG, defined as an unobstructed urethra with uninterrupted contrast flow and no visible narrowing or obstruction. Secondary outcomes included improvement in LUTS, measured using the IPSS, as well as erectile and ejaculatory function, assessed using the IIEF-5 and MSHQ-EJD. Additionally, improvement in QoL and treatment satisfaction were evaluated.

A surgical outcome was considered successful if the following criteria were met: at least a 50% improvement in IPSS, a Q-max ≥ 10 mL/s, and a stricture-free RUG.

Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics were employed, with frequency and percentage for qualitative data, and mean and standard deviation (Mean $\pm$ SD) for continuous quantitative data. The normality of the data was assessed using the Shapiro-Wilk test. For normally distributed data, paired t-tests were used to compare pre- and post-treatment outcomes. For non-normally distributed data, the Wilcoxon signed-rank test was applied. For paired categorical data, the McNemar test was used to assess changes in proportions before and after treatment. The significance level was set at $p < 0.05$.

3. Results

Thirty-eight patients with long-segment urethral stricture were assessed for eligibility. Of these, 31 underwent surgery, completed the 12-month follow-up, and were included in the data analysis (Figure 4).

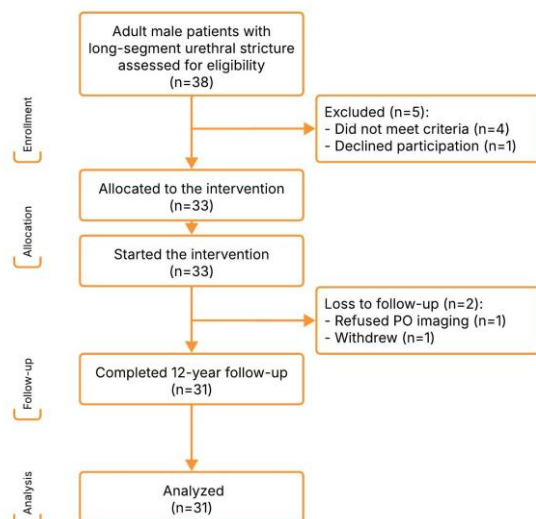


Figure 4. Participant flow diagram of the study. The mean age of the patients was 40.9 ± 14

years. Among the cohort, 22 patients (71%) had previously undergone urethral interventions. More than 60% of cases were due to post-inflammatory and idiopathic causes, with most strictures affecting the peno-bulbar region. The mean stricture length was 6.4 ± 2.3 cm, ranging from 3 to 14 cm, and the corresponding mean graft length was 8 cm. Spinal anesthesia was used in 80% of the procedures. The mean operative time was 115.6 ± 18.9 minutes, ranging from 89 to 160 minutes (Table 1).

Table 1. Demographics, urethral stricture characteristics, and operative data of the 31 studied patients.

VARIABLES	
AGE (YEARS)	40.9 ± 14 (18 - 74)
BODY MASS INDEX (KG/M ²)	24.4 ± 3.3 (16 - 31)
STRICTURE ETIOLOGY	
IDIOPATHIC	13 (41.93)
INFLAMMATORY	7 (22.58)
POST-INSTRUMENTATION	6 (19.35)
TRAUMATIC	5 (16.13)
SUPRAPUBIC CATHETER	8 (25.8)
PRIOR INTERVENTIONS	22 (71.0)
STRICTURE LOCATION	
PROXIMAL BULBAR	3 (9.68)
DISTAL BULBAR	13 (41.93)
WHOLE BULBAR	8 (25.81)
PAN URETHRAL	2 (6.45)
BULBAR AND PROXIMAL PENILE	5 (16.13)
STRICTURE LENGTH (CM)	6.4 ± 2.3 (3 - 14)
LUMEN OBLITERATION	
PARTIAL	23 (74.2)
COMPLETE	8 (25.8)
HARVESTED GRAFT LENGTH (CM)	8 ± 2.8 (4 - 16)
DRAIN INSERTION	6 (19.35)
OPERATIVE TIME (MIN)	115.6 ± 18.9 (89 - 160)
HOSPITAL STAY (HOURS)	30.2 ± 17.7 (24 - 120)

The data are presented as mean $\pm$ SD (range) or number (percentage).

No intraoperative complications were reported. However, postoperative complications occurred in 2 cases (6.45%), both presenting as urethrocutaneous fistulas, which were successfully managed with surgery. During the study period, 2 cases of urethral stricture recurrence were observed, one at 9 months and the other at one-year follow-up (details on the management of these cases are not available). Based on RUG findings and improvements in urinary symptoms and Qmax, the success rate of PSG urethroplasty at 12 months post-surgery was 87.1% (95% CI: 70.17% - 96.37%).

Significant improvements were observed in Q-max ($p < 0.001$), IPSS ($p < 0.001$), and patient satisfaction ($p < 0.001$). However, no statistically significant differences were observed in the pre- and 12-month postoperative scores for erectile function, as assessed by the IIEF-5 ($p = 0.46$), and ejaculatory function, as assessed by the MSHQ-EJD ($p = 0.50$) (Table 2).

Table 2. Functional outcomes and patient satisfaction in the 31 studied patients.

VARIABLES	PREOPERATIVE	12-MONTHS POSTOPERATIVE	P VALUE
IPSS	29.4 ± 6.2	6.5 ± 6	<0.001
Q-MAX (ML/S)	5 ± 2.4	18.5 ± 6.1	<0.001
IIEF-5 SCORE	18.4 ± 5.9	17.7 ± 6	0.449
ED GRADE	13 (41.93)	11 (35.48)	
NO	7 (22.58)	5 (16.13)	

MILD	7 (22.58)	9 (29.03)	
MODERATE	2 (6.45)	5 (16.13)	
SEVERE	2 (6.45)	1 (3.22)	
MSHQ-EJD	10.6 ± 4.5	11 ± 6.2	0.77
PATIENTS			
SATISFACTION	0	11 (35.48)	
DELIGHTED	1 (3.22)	11 (35.48)	
PLEASED	2 (6.45)	4 (12.9)	
MOSTLY	6 (19.35)	2 (6.45)	
SATISFIED	4 (12.9)	1 (3.22)	
EQUALLY	6 (19.35)	1 (3.22)	
SATISFIED/DISSATISFIED	12 (38.7)	1 (3.22)	
MOSTLY			
DISSATISFIED			
UNHAPPY			
TERRIBLE			

The data are presented as mean $\pm$ SD or number (percentage).

IIEF, International Index of Erectile Function; IPSS, International Prostate Symptom Score; MSHQ-EJD, Male Sexual Health Questionnaire for Ejaculatory Dysfunction; Qmax, Peak Flow Rate; QOL, Quality of Life.

4. Discussion

Historically, PSGs were the primary graft material for substitution urethroplasty from the 1960s until the early 1990s, when BMG became the more commonly used material. Despite this, PSGs remain an important option alongside BMG in urethral reconstruction today.¹¹⁻¹³

Devine CJ Jr. first used a tubularized full-thickness PSG to reconstruct a strictured urethral meatus and fossa navicularis, marking an early application of skin grafts in urethral reconstruction.¹⁴ The use of PSGs was significantly advanced when Asopa et al. published their results on the use of grafts for reconstructing urethral strictures, further establishing its utility.¹⁵

In 2008, Bracka demonstrated that preputial skin, a hairless and flexible tissue with reliable take and adaptability to moist environments, could be used effectively for urethral reconstruction.¹⁶ Radopoulos and colleagues studied the use of dorsal onlay preputial skin grafts in 21 patients with anterior urethral strictures, reporting a 28.6% recurrence rate after a median follow-up of 50 months.¹⁷ Similarly, Barbagli et al. studied 38 patients who underwent bulbar urethroplasty using penile/preputial skin grafts in a dorsal onlay fashion, reporting a 34.2% failure rate after a long follow-up period of 111 months. They concluded that PSGs are a useful tool for the repair of urethral stricture.¹⁸

In our study, we reported a success rate of 87% for PSG urethroplasty, with significant relief of LUTS, as evidenced by sustained improvement in IPSS and Q-max scores. Additionally, our data demonstrated the preservation of erectile and ejaculatory functions in the operated patients. This high success rate is consistent with the findings of Wessells and McAninch,¹⁹ the 'Pee'BuSt trial,²⁰ and Hussein et al.²¹

A 2020 systematic review and meta-analysis by

Sharma et al.⁴ compared the outcomes of PSG versus BMG for substitution urethroplasty. The study included 16 studies, five prospective and 11 retrospective, analyzing a total of 1,406 patients (896 BMG and 510 PSG). The authors found that BMG had a significantly higher success rate than PSG (83.7% vs. 76.1%, $p < 0.0001$). In the subgroup analysis of bulbar urethroplasty, BMG showed a higher success rate than PSG (87.4% vs. 78%, $p = 0.0001$), indicating the superiority of BMG over PSG. Our study, however, reported a success rate with PSG that is comparable to that seen in their BMG group.

The surgical technique used for graft urethroplasty plays an essential role in determining the success of the procedure and preserving erectile and ejaculatory function. In our study, we performed unilateral dorsolateral mobilization of the urethra with dorsal onlay graft urethroplasty after sparing the bulbospongiosus muscle. This technique preserves the contralateral urethral blood supply, reducing the risk of ischemia, and maintains the bulbospongiosus muscle, which helps preserve ejaculatory function.^{22,23} The dorsal onlay approach also minimizes the risk of urethral diverticulae.⁸

For very long stricture segments, bilateral BMG or a long spiral PSG was harvested. PSGs have the advantage of being wider than BMGs and avoid the need for anastomosing two BMGs, which alleviates the risk of anastomotic site strictures. Another advantage of PSG over BMG is that the procedure can be performed under regional anesthesia, decreasing the risk of transmission of infectious respiratory complications. This makes PSG particularly advantageous in situations where general anesthesia poses higher risks, especially for high-risk patients who may not tolerate general anesthesia. In our study, 80.6% of patients underwent the procedure under spinal anesthesia.

To avoid the complications of using hairy skin for urethral reconstruction, we utilized non-hairy penile skin from the penile shaft. This type of skin was available in all our cases, regardless of circumcision status, ensuring that penile skin availability was not a concern. PSGs have the advantage of being easily harvested from the same operative field, eliminating the need for two separate operative teams, which is often necessary for BMG harvesting. Additionally, penile skin has similar tissue characteristics to native urethral tissue and is elastic, making it an ideal material for substitution. Moreover, the donor site is easily concealed.^{3,20}

Although our study was prospective, it has several limitations. It is a single-arm study with

a relatively short follow-up period of 12 months. Additionally, we were unable to assess the long-term contractility of the graft over time, which is an important consideration for long-term outcomes in urethral substitution.

4. Conclusion

Our study demonstrates that the PSG technique for anterior urethroplasty has high success rates, with excellent patient satisfaction and preservation of sexual and ejaculatory functions. PSG remains a viable option for urethral reconstruction, particularly in patients with long anterior strictures.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

Funding

No Funds : Yes

Conflicts of interest

There are no conflicts of interest.

References

- Andrich DE, Mundy AR. What is the best technique for urethroplasty? *European urology*. 2008;54(5):1031-41.
- Dubey D, Vijjan V, Kapoor R, et al. Dorsal onlay buccal mucosa versus penile skin flap urethroplasty for anterior urethral strictures: results from a randomized prospective trial. *The Journal of urology*. 2007;178(6):2466-9.
- Levy ME, Elliott SP. Graft use in bulbar urethroplasty. *Urologic Clinics*. 2017;44(1):39-47.
- Sharma G, Sharma S, Parmar K. Buccal mucosa or penile skin for substitution urethroplasty: a systematic review and meta-analysis. *Indian Journal of Urology*. 2020;36(2):81-8.
- Ahmed A. Substitution Urethroplasty in the Management of Anterior Urethral Stricture Disease-a Study of 50 Cases. *Saudi J Med*. 2020;6(6):169-75.
- Alsikafi NF, Eisenberg M, McAninch JW. 317: Long-Term outcomes of Penile Skin Graft Versus Buccal Mucosal Graft for Substitution Urethroplasty of the Anterior Urethra. *The Journal of Urology*. 2005;173(4S):87-8.
- Barbagli G, Guazzoni G, Lazzeri M. One-stage bulbar urethroplasty: retrospective analysis of the results in 375 patients. *European urology*. 2008;53(4):828-33.
- Kulkarni S, Barbagli G, Sansalone S, Lazzeri M. One-sided anterior urethroplasty: a new dorsal onlay graft technique. *BJU international*. 2009;104(8):1150-5.
- Rosen RC, Cappelleri J, Smith M, Lipsky J, Pena B. Development and evaluation of an abridged, 5-item version of the International Index of Erectile Function (IIEF-5) as a diagnostic tool for erectile dysfunction. *International journal of impotence research*. 1999;11(6):319-26.
- Rosen RC, Catania JA, Althof SE, et al. Development and validation of four-item version of Male Sexual Health Questionnaire to assess ejaculatory dysfunction. *Urology*. 2007;69(5):805-9.

- 11.Devine PC, Horton CE, Devine C, Devine CJ, Crawford HH, Adamson JE. Use of full thickness skin grafts in repair of urethral strictures. *The Journal of Urology*. 1963;90(1):67-71.
- 12.Martins FE, De Oliveira PS, Martins NM. Historical Perspective and Innovations in Penile Urethroplasty. *Lower Urinary Tract Dysfunction-From Evidence to Clinical Practice*: IntechOpen; 2019.
- 13.Hudak SJ, Hudson TC, Morey AF. 'Minipatch'penile skin graft urethroplasty in the era of buccal mucosal grafting. *Arab Journal of Urology*. 2012;10(4):378-81.
- 14.Devine Jr C. Surgery of the urethra. *Campbell's urology*, 5th edn Saunders, Philadelphia. 1986:2860-3.
- 15.Asopa HS, Garg M, Singhal GG, Singh L, Asopa J, Nischal A. Dorsal free graft urethroplasty for urethral stricture by ventral sagittal urethrotomy approach. *Urology*. 2001;58(5):657-9.
- 16.Bracka A. The role of two-stage repair in modern hypospadiology. *Indian Journal of Urology*. 2008;24(2):210-8.
- 17.Radopoulos D, Tzakas C, Dimitriadis G, Vakalopoulos I, Ioannidis S, Vasilakakis I. Dorsal on-lay preputial graft urethroplasty for anterior urethra strictures repair. *International Urology and Nephrology*. 2007;39:497-503.
- 18.Barbagli G, Morgia G, Lazzeri M. Dorsal onlay skin graft bulbar urethroplasty: long-term follow-up. *European urology*. 2008;53(3):628-34.
- 19.Wessells H, McAninch JW. Use of free grafts in urethral stricture reconstruction. *The Journal of urology*. 1996;155(6):1912-5.
- 20.Tyagi S, Parmar KM, Singh SK, et al. Pee'BuSt Trial: A single-centre prospective randomized study comparing functional and anatomic outcomes after augmentation urethroplasty with penile skin graft versus buccal mucosa graft for anterior urethral stricture disease. *World Journal of Urology*. 2022:1-7.
- 21.Hussein MM, Almogazy H, Mamdouh A, et al. Urethroplasty for treatment of long anterior urethral stricture: buccal mucosa graft versus penile skin graft—does the stricture length matter? *International urology and nephrology*. 2016;48:1831-5.
- 22.Kartal I, Çimen S, Kokurcan A, Akay EO, Yiğitbaşı O, Yalçınkaya F. Comparison between dorsal onlay and one-sided dorsolateral onlay buccal mucosal graft urethroplasty in long anterior urethral strictures. *International Journal of Urology*. 2020;27(9):719-24.
- 23.Islam M, Haque M, Islam M, et al. Dorsolateral onlay OMG urethroplasty through unilateral urethral mobilization in anterior urethral stricture-our experience in dhaka medical college hospital and salam urology & transplantation foundation of bangladesh (SUTF). *Bangladesh Journal of Urology*. 2011;14(1):22-5.