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MODERN APPROACHES TO DIAGNOSIS AND TREATMENT OF URETHRAL STRICTURES

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Abstract
Urethral stricture remains one of the most clinically challenging conditions in reconstructive urology, demanding precise diagnostic evaluation and individualized treatment selection. This article reviews contemporary diagnostic modalities and surgical techniques - including drug-coated balloon dilation, buccal mucosal graft urethroplasty, and endoscopic urethrotomy - with emphasis on comparative outcome data and evidence-based treatment algorithms from current international guidelines.

Keywords: Urethral stricture, spongiofibrosis, retrograde urethrography, uroflowmetry, cystourethroscopy, direct visual internal urethrotomy, urethroplasty, buccal mucosal graft, anastomotic urethroplasty, drug-coated balloon, paclitaxel dilation, stricture recurrence, urethral reconstruction, substitution urethroplasty, voiding cystourethrography.

Introduction

Urethral stricture disease represents a pathological narrowing of the urethral lumen resulting from spongiofibrosis - the replacement of healthy erectile tissue with collagen-rich scar - leading to obstructive voiding symptoms of varying severity. The condition affects approximately 100 in every 100,000 adult males, and its true prevalence may be underestimated given the non-specific nature of its symptomatic presentation, which frequently overlaps with benign prostatic hyperplasia, overactive bladder, and urinary tract infection. Patients most commonly present with a weak urinary stream, incomplete bladder emptying, urinary spraying, and dysuria, though sexual dysfunction is documented in a minority. The etiological spectrum is broad - encompassing idiopathic, iatrogenic, inflammatory, and traumatic causes - and the chosen treatment must be calibrated precisely to stricture length, location, etiology, and recurrence history. This paper synthesizes current diagnostic standards and treatment evidence.

Literature review

The diagnostic and therapeutic landscape of urethral stricture has been shaped by several landmark contributions. Martov and Gorilovskiy established foundational principles of endoscopic urethrotomy in the Russian-language literature, documenting its limitations in recurrent and long-segment disease. Pushkar and colleagues provided comprehensive analysis of reconstructive urethroplasty outcomes in the Russian urological practice, delineating anatomical success criteria and long-term follow-up protocols. Alimdzhanov's work within Central Asian urology identified the predominance of iatrogenic and post-inflammatory stricture etiologies in the regional patient population. The American Urological Association's 2023 amended guideline consolidated evidence from 331 publications, establishing evidence-based treatment selection algorithms applicable across stricture phenotypes.

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Kulkarni and Joshi further demonstrated that buccal mucosal graft urethroplasty achieves durable anatomical patency exceeding 85% at five-year follow-up in complex anterior strictures.

Methodology

This study was conducted at the Urology Department of the Fergana Regional Multidisciplinary Medical Center in collaboration with the Fergana Medical Institute of Public Health over a 24-month period spanning January 2022 to January 2024. A total of 86 male patients with confirmed urethral stricture disease were enrolled and prospectively followed. Mean patient age was 41.3 12.7 years (range: 18-74 years). Stricture etiology distribution was as follows: iatrogenic (post-catheterization, post-transurethral resection, post-prostatectomy) - 34 patients (39.5%); post-inflammatory (gonococcal, non-specific urethritis) - 22 patients (25.6%); post-traumatic - 18 patients (20.9%); and idiopathic - 12 patients (14.0%).

All 86 patients underwent a standardized four-stage diagnostic workup. Stage 1: Symptom quantification - the International Prostate Symptom Score (IPSS) and Quality of Life (QoL) index were recorded for every patient at enrollment. Mean IPSS at baseline was 22.6 4.3 (range: 11-35), indicating predominantly moderate-to-severe obstructive symptomatology. Stage 2: Uroflowmetry and post-void residual measurement - peak urinary flow rate (Qmax) was measured using a calibrated uroflowmeter (Urodyn 1000, Dantec Medical). Mean Qmax at baseline was 5.8 2.1 mL/s, significantly below the age-adjusted normal threshold of 15 mL/s. Post-void residual (PVR) was assessed by transabdominal ultrasound immediately following voiding; mean PVR was 148.4 63.2 mL. Stage 3: Imaging - retrograde urethrography (RUG) was performed in all 86 patients using standard fluoroscopic technique with 30% iodine contrast, providing definitive localization and length measurement of the stricture. In 31 patients (36.0%) with suspected posterior urethral involvement or post-operative bladder neck contracture, combined voiding cystourethrography (VCUG) was added. Ultrasound urethrography (SUG) was applied in 24 patients (27.9%) to assess spongiofibrosis depth, a parameter not reliably obtained by conventional fluoroscopy. Stage 4: Endoscopic evaluation - flexible cystourethroscopy was performed in all patients, allowing direct visual confirmation of stricture diameter, mucosal quality, and proximal urethral anatomy. Treatment Allocation. Based on integrated diagnostic findings - stricture length, location, degree of spongiofibrosis, and recurrence history - patients were allocated to one of three treatment modalities: (1) Direct Visual Internal Urethrotomy (DVIU) with or without adjunct drug-coated balloon (DCB) dilation - 38 patients (44.2%); (2) Anastomotic urethroplasty (excision and primary anastomosis, EPA) - 24 patients (27.9%); (3) Substitution urethroplasty using buccal mucosal graft (BMG) - 24 patients (27.9%). Follow-up was conducted at 1, 3, 6, 12, and 24 months post-intervention, incorporating repeat uroflowmetry, IPSS scoring, and flexible urethroscopy at the 6-month and 24-month timepoints to assess anatomical patency.

Results

Diagnostic Findings. Stricture localization data revealed that bulbar urethral involvement was the most prevalent, accounting for 47 cases (54.7%), followed by penile urethra in 21 cases (24.4%), combined bulbar-penile in 11 cases (12.8%), and posterior (membranous-prostatic) urethra in 7 cases (8.1%). Mean stricture length across the entire cohort was 2.7 1.4 cm (range: 0.5-8.5 cm). Among the

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24 patients assessed with SUG, significant periurethral fibrosis exceeding 2 mm in depth was identified in 14 (58.3%), a finding that directly influenced surgical planning toward substitution rather than anastomotic repair in these individuals.

The correlation between Qmax and stricture luminal diameter was statistically significant (Pearson r = 0.74, p<0.001): patients with Qmax <5 mL/s uniformly demonstrated stricture diameters 10 Fr on endoscopic assessment, while those with Qmax between 5-10 mL/s showed diameters of 10-14 Fr. This confirmed uroflowmetry as a valid, non-invasive screening tool, with RUG serving as the definitive anatomical characterization modality.

Group 1 - DVIU DCB (n=38): Among the 38 patients in this group, 19 received standard cold-knife DVIU alone, and 19 underwent DVIU combined with paclitaxel-coated balloon dilation (Optilume® DCB). In the DVIU-alone subgroup, anatomical recurrence (defined as stricture diameter <16 Fr on follow-up urethroscopy) occurred in 11 patients (57.9%) by 24 months, consistent with the established high recurrence profile of isolated endoscopic treatment. In the DCB subgroup, only 4 patients (21.1%) required repeat intervention by 24 months - a recurrence rate reduction of 63.6% compared to DVIU alone. Mean Qmax improved from 5.4 1.9 mL/s at baseline to 14.6 3.1 mL/s at 6 months in the DCB subgroup, with maintenance at 13.8 3.4 mL/s at 24 months. Mean IPSS in the DCB subgroup fell from 23.1 4.1 to 9.3 3.7 at 24 months.

Group 2 - Anastomotic Urethroplasty (n=24): Anatomical success at 24 months was achieved in 21 patients (87.5%). Mean Qmax rose from 5.2 2.0 mL/s to 19.4 3.8 mL/s at 6 months and remained at 18.1 4.2 mL/s at 24 months. Mean IPSS decreased from 21.9 4.7 to 6.8 2.9. Three patients (12.5%) developed recurrent stricture and required repeat intervention: one underwent successful DCB dilation, two proceeded to substitution urethroplasty. Group 3 - Buccal Mucosal Graft Urethroplasty (n=24): Anatomical success was recorded in 20 patients (83.3%) at 24 months. Mean Qmax improved from 5.1 2.3 mL/s to 17.6 4.0 mL/s at 6 months, stabilizing at 16.9 4.5 mL/s by 24 months. The mean IPSS fell from 23.4 3.9 to 7.4 3.1. Donor-site oral morbidity (transient hyposalivation, altered tongue sensitivity) was reported by 7 patients (29.2%) but resolved spontaneously within 3 months in all cases.

Discussion

The findings of this study reinforce several key principles emerging from contemporary urological evidence regarding urethral stricture management, while contextualizing them within the clinical realities of a regional Central Asian urology practice.

The high recurrence rate associated with DVIU alone - 57.9% in our series at 24 months - is consistent with international data showing 50-70% failure for treatment-naïve short strictures and substantially higher failure rates for recurrent disease. This observation underscores the inadequacy of isolated endoscopic urethrotomy as a definitive management strategy for strictures beyond a single occurrence or exceeding 1-2 cm in length. Yet it remains common practice in resource-limited settings precisely because of its technical simplicity and low perioperative burden. The integration of drug-coated balloon technology addresses this gap in a clinically meaningful way: in our DCB subgroup, the 24-month recurrence rate of 21.1% compares favorably with the 23.6% freedom-from-reintervention rate at one year reported in the control arm of the ROBUST III trial, while the DCB arm of ROBUST III

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achieved 77.8% freedom from reintervention at two years - consistent with the directionality of our own findings.

The superiority of open urethroplasty - both anastomotic and substitution - over endoscopic management in terms of long-term anatomical durability is clearly demonstrated by our 87.5% and 83.3% success rates at 24 months for EPA and BMG techniques, respectively. These align with the 80-95% success range reported in the international reconstructive literature. A critical diagnostic implication arises from the SUG findings: among patients in whom deep spongiofibrosis was confirmed (fibrosis >2 mm in 58.3% of SUG-assessed patients), proceeding with anastomotic repair without adequate fibrosis clearance carried substantially higher recurrence risk. This finding emphasizes that uroflowmetry and RUG, while essential, are insufficient alone to characterize the full extent of periurethral disease; SUG adds an independent anatomical dimension that directly informs surgical technique selection. One area requiring particular attention in the regional context is diagnostic delay. The mean IPSS of 22.6 at presentation in our cohort reflects a patient population that has tolerated significant obstructive symptomatology for prolonged periods before seeking urological evaluation, likely due to limited primary-care awareness of the condition. Early referral pathways and wider deployment of uroflowmetry as a first-line screening tool could substantially reduce the anatomical complexity of strictures encountered at the time of first specialist consultation, improving overall treatment outcomes and reducing the need for complex reconstructive procedures. Contemporary urethral stricture management demands individualized, diagnostically grounded treatment selection. Uroflowmetry, retrograde urethrography, and ultrasound urethrography collectively provide the diagnostic precision required for accurate surgical planning. Open urethroplasty delivers superior long-term patency, while drug-coated balloon dilation represents a valid minimally invasive alternative for recurrent short strictures, achieving clinically meaningful and durable outcomes.

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