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Ultra-minimally Invasive Prostatic Urethral Dilation for Small-volume Benign Prostatic Obstruction: A Case Report

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Abstract: *Background*: Small-volume benign prostatic obstruction (BPO) represents a distinct clinical phenotype in which lower urinary tract symptoms (LUTS) are often driven by functional and microenvironmental factors rather than anatomical enlargement. Conventional treatment strategies may be less effective in this subgroup. *Case presentation*: We report the case of a 66-year-old male with severe LUTS and a small prostate volume (20 mL) who showed inadequate response to medical therapy. The patient underwent prostatic urethral dilation (PUD) using an ultra-minimally invasive prostate dilation catheter (Longevity bar). At 3-month follow-up, improvements were observed in symptom score, urinary flow rate, and post-void residual volume, while sexual function was preserved, and no procedure-related complications occurred. *Conclusion*: PUD may provide a potential treatment option for selected patients with small-volume BPO. Further studies are needed to determine its long-term efficacy and clinical role.

Keywords: Benign prostatic obstruction; Prostatic urethral dilation; LUTS; Minimally invasive therapy

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1. Introduction

Benign prostatic hyperplasia (BPH) is a common pathological basis of lower urinary tract symptoms (LUTS) in aging men [1]. Clinically, its significance lies not only in prostate enlargement itself, but also in the development of benign prostatic obstruction (BPO), which reflects increased bladder outlet resistance and impaired urinary emptying [2,3]. However, increasing evidence suggests that this volume-based paradigm is insufficient, particularly in patients with small prostate volume, where symptom severity often shows poor correlation with gland size [4]. In this context, small-volume BPO represents a clinically meaningful phenotype, because the key problem is not marked glandular enlargement but the presence of outlet

resistance and impaired urinary emptying.

In this subgroup, functional factors including increased smooth muscle tone, chronic inflammation, fibrosis, and neural dysregulation are considered to play a key role in the development of obstruction and symptom generation [5–8]. These observations have prompted growing interest in treatment approaches that target underlying functional mechanisms rather than relying solely on tissue removal [9].

Prostatic urethral dilation (PUD) is an emerging ultra-minimally invasive technique that reduces urethral resistance through controlled mechanical expansion without tissue ablation [10]. By preserving mucosal integrity and limiting structural disruption, PUD may be particularly relevant in patients with predominantly functional obstruction [10]. This mechanism is especially relevant to small-volume BPO, where reducing urethral resistance may be more important than reducing prostate volume.

However, clinical evidence regarding the application of PUD in small-volume BPO remains limited, and real-world case-based insights are needed to better define its role in this specific phenotype.

2. Case presentation

A 66-year-old male presented with a 2-year history of progressively worsening lower urinary tract symptoms (LUTS), including urinary frequency, nocturia (1–2 times per night), weak urinary stream, and a sensation of incomplete bladder emptying. These symptoms significantly affected his daily activities and sleep quality.

Baseline evaluation showed an International Prostate Symptom Score (IPSS) of 22 and a quality-of-life (QoL) score of 5. Uroflowmetry demonstrated a maximum urinary flow rate (Qmax) of 15 mL/s, and ultrasound revealed a post-void residual (PVR) volume of 151 mL. Transrectal ultrasonography measured a prostate volume of 20 mL.

The patient had received α_1-adrenergic receptor antagonist therapy for 6 months, with limited symptom improvement [11,12]. Given the small prostate volume and concerns regarding potential sexual dysfunction, the patient declined surgical options such as transurethral resection of the prostate (TURP) and holmium laser enucleation of the prostate (HoLEP) [2,13].

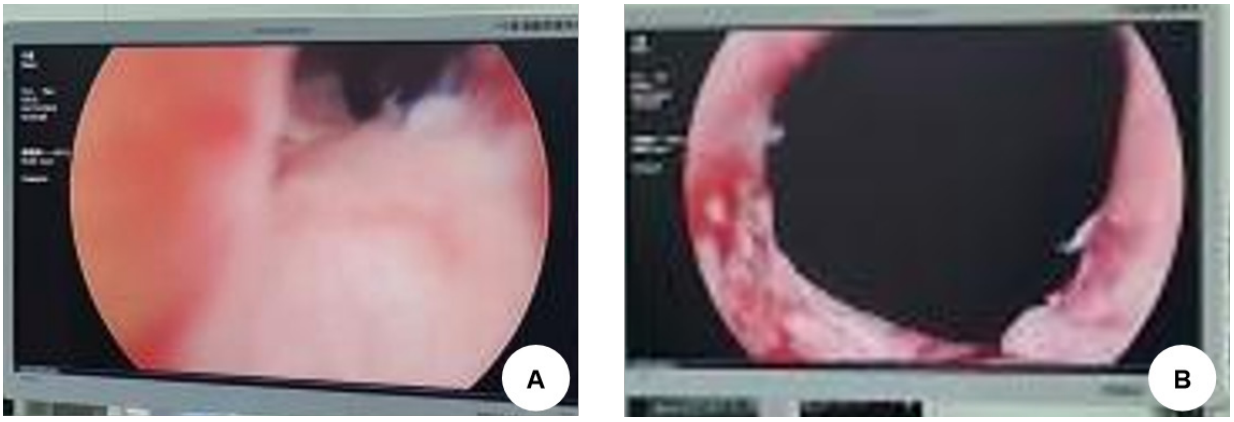
After informed consent, prostatic urethral dilation was performed under general anesthesia. An ultra-minimally invasive prostate dilation catheter (Longevity bar: F16-32T) was inserted transurethrally under cystoscopic guidance. The balloon was gradually inflated to a working pressure of approximately 0.3 MPa and maintained for 10 minutes to achieve dilation of the prostatic urethra. Positioning and expansion were continuously assessed during the procedure.

The total procedure time was approximately 20 minutes. No intraoperative complications occurred, and the Foley catheter was removed within 24 hours.

At the 3-month follow-up, clinical parameters improved. The IPSS decreased from 22 to 15, Qmax increased from 15 to 19 mL/s, and PVR decreased from 151 mL to 30 mL. Sexual function was preserved, with no evidence of retrograde ejaculation or erectile dysfunction.

No adverse events, including urinary incontinence, urinary tract infection, or urethral stricture, were observed during follow-up.

Comparative cystoscopic evaluation demonstrated improved bladder neck opening following PUD and Longevity bar. The previously obstructed segment of the prostatic urethra was dilated, with restoration of luminal patency. No mucosal injury or bleeding was observed, and the dilation contour appeared well defined (**Figure 1**).



A: Preoperative cystoscopic image of the patient; **B**: Postoperative cystoscopic image of the patient.

Figure 1. Comparative cystoscopic images of the patient before and after PUD surgery.

3. Discussion

This case suggests the potential role of PUD in the management of small-volume benign prostatic obstruction (BPO) [4]. In contrast to conventional approaches that primarily focus on reducing prostate volume, PUD, and the Longevity bar act by decreasing urethral resistance through controlled mechanical expansion [2,3,10,14].

In this patient, the relatively preserved Qmax despite severe LUTS suggests the presence of functional obstruction [15]. Factors such as increased urethral tone, reduced urethral compliance, and possible bladder dysfunction may contribute to symptom severity [16]. This observation is in line with previous reports indicating that, particularly in small-volume BPO, symptom burden does not always correlate with prostate size, and functional components may play a more prominent role [4,17].

The improvements in urinary flow and symptom score observed after the procedure indicate that functional factors were likely predominant in this case. Mechanical dilation may reduce outlet resistance without inducing thermal injury or ischemic necrosis, thereby preserving tissue integrity [18]. In addition, by avoiding tissue destruction, this approach may reduce the risk of secondary inflammatory responses and fibrosis, which have been implicated in persistent or recurrent LUTS [7,19,20].

Preservation of sexual function was also observed during follow-up [21]. This finding is clinically relevant, as ejaculatory dysfunction remains a frequent concern after resective procedures such as TURP or laser-based techniques [21]. For patients who prioritize the maintenance of sexual function, non-resective approaches may offer a more acceptable therapeutic option [9].

When compared with other minimally invasive therapies, PUD differs in its mechanism of action. Procedures such as prostatic urethral lift (PUL) primarily relieve obstruction through mechanical retraction, while techniques such as Rezūm or prostatic artery embolization (PAE) rely on tissue ablation or ischemia [9]. In contrast, PUD and the Longevity bar can directly target the dynamic component of obstruction without altering tissue viability [10]. This characteristic may be particularly relevant in patients with small prostate volume, where anatomical enlargement is limited and functional factors are more prominent [4].

From a practical perspective, PUD and the Longevity bar may also offer advantages in terms of procedural simplicity and recovery. Under appropriate clinical conditions, this procedure may be performed

under local anesthesia in selected patients, with a relatively short operative time and early catheter removal, which may facilitate recovery and reduce perioperative burden [22]. However, these potential benefits require confirmation in larger clinical cohorts.

These observations should be interpreted with caution. Evidence on PUD remains limited, and questions remain regarding its long-term outcomes, durability of symptom relief, and appropriate patient selection. In addition, pressure-flow urodynamic assessment was not performed in this case, which limits further characterization of the underlying mechanism. Further prospective studies are warranted to clarify its role in clinical practice.

This case also highlights an important clinical distinction between prostate size and the mechanism of obstruction. In routine practice, men with a small prostate may be considered less likely to have clinically relevant obstruction because anatomical enlargement is limited. However, gland size alone does not fully explain LUTS severity. Current evidence and guidelines emphasize that the assessment of male LUTS should integrate symptom burden, urinary flow, post-void residual volume, prostate morphology, and the possibility of functional obstruction [23]. In selected patients, increased outlet resistance may arise from bladder neck stiffness, periurethral fibrosis, enhanced smooth muscle tone, chronic inflammatory remodeling, or impaired relaxation of the prostatic urethra rather than from glandular enlargement itself [7,24]. Therefore, a treatment strategy guided only by prostate volume may overlook the dominant pathophysiological mechanism, particularly in patients with severe symptoms and substantial residual urine despite a small gland [4,25].

In the present patient, the prostate volume was 20 mL, yet the symptom burden was severe, and the baseline PVR was markedly elevated. These findings suggest that the obstruction was unlikely to be explained by tissue bulk alone. Reduced urethral compliance and functional narrowing of the prostatic urethra may have contributed substantially to impaired bladder emptying. From this perspective, PUD represents a mechanism-directed intervention rather than a volume-reducing procedure. Instead of removing, vaporizing, or devascularizing prostatic tissue, controlled circumferential dilation aims to enlarge the functional urethral channel and reduce outlet resistance [10]. This non-resective principle is particularly relevant for small-volume BPO, where the therapeutic target is often urethral resistance rather than excess adenomatous tissue [4,10].

Another point of interest is mucosal preservation. Local tissue injury, edema, inflammation, and fibrotic repair may contribute to persistent or recurrent LUTS after some interventions for BPH/BPO [26,27]. A dilation-based approach avoids thermal injury and tissue necrosis, which may help reduce secondary inflammatory remodeling. In this case, postoperative cystoscopy showed improved opening of the bladder neck and prostatic urethra, with no obvious mucosal bleeding or structural disruption. Although this single observation cannot establish long-term benefit, it provides visual support for the concept that controlled dilation can restore luminal patency while maintaining mucosal integrity [10].

Appropriate patient selection is essential. Based on the mechanism of action, PUD may be most relevant for patients with small-to-moderate prostate volume, suspected functional obstruction, inadequate response to medical therapy, and a strong preference for preserving sexual function [4,9,10]. It may also be considered for elderly or medically vulnerable patients in whom a shorter, less invasive procedure is desirable, although this indication requires further validation. Preoperative evaluation should therefore extend beyond prostate volume and include IPSS, QoL score, uroflowmetry, PVR, prostate imaging, cystoscopic assessment, and, when clinically indicated, urodynamic testing. Patients with severe detrusor underactivity, neurogenic bladder, active urinary infection, urethral stricture, or suspected malignancy should be carefully evaluated

before considering this approach [28].

The reduction in PVR observed in this case is also noteworthy. Although the increase in Qmax was moderate, the decrease in residual urine from 151 mL to 30 mL suggests a meaningful improvement in bladder emptying efficiency. PVR reflects the interaction between outlet resistance and detrusor function, and therefore provides complementary information to Qmax alone [29]. This is particularly relevant in small-volume BPO, where baseline urinary flow may not always be severely reduced despite bothersome symptoms, incomplete emptying, and impaired quality of life. In such patients, treatment response should be interpreted using both subjective symptom scores and objective functional indicators [4].

Several limitations should be acknowledged. This is a single case with short-term follow-up, and urodynamic testing was not performed; therefore, the underlying obstruction mechanism cannot be definitively confirmed. The durability of symptom relief after PUD also remains uncertain. Future prospective studies should use standardized selection criteria, longer follow-up, validated symptom and functional outcomes, and serial cystoscopic or imaging evaluation where appropriate. Comparative studies against medical therapy, TURP, HoLEP, PUL, Rezūm, prostatic artery embolization, and other minimally invasive treatments would be valuable. Such evidence is needed to determine whether PUD has a defined role in the treatment pathway for small-volume BPO and whether its non-resective, mucosa-preserving mechanism can translate into durable improvement with fewer functional complications.

4. Limitations

This report has several limitations. First, it represents a single case with a relatively short follow-up period. Second, a pressure-flow urodynamic assessment was not performed to characterize the underlying mechanism of obstruction further. Therefore, the generalizability of these findings remains limited.

5. Conclusion

This case suggests that prostatic urethral dilation may provide significant symptomatic and functional improvement in patients with small-volume BPO while preserving sexual function. As a non-resective and mechanism-based approach, PUD may represent a potential addition to the current therapeutic options. A phenotype-driven approach based on underlying mechanisms may allow more individualized management of patients with LUTS [30]. Further prospective studies with larger sample sizes and longer follow-up are warranted to confirm these findings and clarify their clinical role. Ethics approval and consent to participate: This study was conducted in accordance with the principles of the Declaration of Helsinki. The institutional review board waived ethical approval, as this is a single case report and does not involve identifiable patient information. Consent for publication: Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor of this journal upon request.

Disclosure statement

The authors declare no conflict of interest.

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