

Research Article

# Endoscopic Balloon Dilation Under Fluoroscopic Guidance for the Treatment of Urethral Strictures in Chad: Initial Experience

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## Abstract

**Introduction:** Male urethral stricture disease is a common condition in sub-Saharan Africa, associated with significant morbidity. Fluoroscopy-guided endoscopic balloon dilation, a minimally invasive technique that applies uniform radial force, has emerged as a promising alternative to conventional endoscopic approaches. However, data from African settings, particularly from Chad, remain limited. This study aimed to evaluate the feasibility and functional outcomes of this technique in our setting. **Methods:** We conducted a prospective, observational, and analytical study at the University Hospital Center La Renaissance in N'Djamena over an 18-month period (November 2024–October 2025). Thirty consecutive adult patients with a single, short urethral stricture were included. Balloon dilation was performed under fluoroscopic guidance. The primary endpoint was success, defined as the absence of clinical or endoscopic recurrence. Secondary endpoints included complications, time to recurrence, and the need for additional intervention. **Results:** The mean age of patients was 36.9 years, and the mean delay before consultation was 9 months. Symptoms were predominantly obstructive, mainly dysuria with reduced urinary flow. A suprapubic cystostomy was present in 20% of patients. Bulbar strictures were the most common location. The procedure was performed under spinal anesthesia in 97% of cases, with a mean operative time of 23 minutes. Significant clinical improvement was observed, including increased urinary flow and reduced post-void residual urine. At 6 months, the overall success rate was approximately 90%, with a recurrence rate of 10%. Two patients required repeat dilation. **Conclusion:** Fluoroscopy-guided endoscopic balloon dilation is a feasible, safe, and effective short-term treatment for short urethral strictures in Chad. It represents a valuable option in resource-limited settings, although studies with longer follow-up are needed to confirm its durability.

## Keywords

Urethral Stricture, Balloon Dilation, Fluoroscopy, Minimally Invasive Urologic Procedures, Chad

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## 1. Introduction

Male urethral stricture is an ancient and common urological condition, defined as an abnormal narrowing of the urethral lumen secondary to a fibrotic process [1]. The reported incidence of urethral strictures ranges between 0.6% and 1.4% [2]. In sub-Saharan Africa, urethral stricture disease represents one of the major urological conditions, with a particularly high prevalence. This high burden is associated with significant comorbidity, contributing to substantial morbidity and a marked deterioration in patients' quality of life [3]. Clinically, it presents with debilitating lower urinary tract symptoms, ranging from dysuria to acute urinary retention, and may lead to severe complications such as bladder stone formation, chronic infection, or obstructive renal failure [4]. Management of urethral stricture disease relies on various therapeutic modalities, depending on the site, length, and etiology of the stricture. Urethral dilation and direct vision internal urethrotomy have long been part of the therapeutic armamentarium for urethral strictures. The success rate of these interventions is highly dependent on stricture length, location, and the degree of spongiositis [5]. In a comparative analysis, Kumano et al. demonstrated significantly superior outcomes in favor of balloon dilation. The stricture-free survival time was significantly longer after balloon dilation compared with optical internal urethrotomy. Both techniques have undergone recent advancements, including the use of holmium: YAG laser combined with intralesional triamcinolone injection for internal urethrotomy [5], as well as drug-coated balloon technologies using paclitaxel for stricture management [6]. Balloon dilation has been reported as a simple, minimally invasive, well-tolerated procedure that can be performed on an outpatient basis and is relatively easy to master [7]. This technique exerts a uniform radial force on the stricture site, resulting in reduced mucosal trauma and a lower risk of secondary spongiositis compared with rigid dilators [1]. However, balloon dilation appears to be less effective as a salvage strategy for recurrent bulbar urethral strictures following failed urethroplasty, as demonstrated by Yi et al., highlighting the limitations of this approach in complex or recurrent cases [8]. Given the scarcity of local data despite the high prevalence of urethral stricture disease in Chad, we conducted this study to evaluate our institutional experience in the management of urethral strictures using balloon dilation.

## 2. Methods

### 2.1. Ethical Framework and Study Design

After institutional approval and in accordance with the principles of the Declaration of Helsinki [9], this study was conducted in compliance with international ethical standards and reported following the STROBE guidelines [10]. This was a prospective, observational, analytical study performed in the Urology Department of the University Teaching Hospital La Renaissance in N'Djamena (Chad), over an 18-month period (November 2024 to October 2025). The study included 30 male patients aged over 18 years, presenting with a single, short urethral stricture (less than xxx cm), consecutively treated by balloon dilatation. Diagnosis was confirmed by retrograde urethrography or cystoscopy. Exclusion criteria included strictures secondary to urological malignancy, trauma-related strictures, and patients with incomplete follow-up. Collected data included demographic, clinical, and anatomical characteristics of the stricture, as well as post-procedural outcomes.

### 2.2. Operative Technique

Antibiotic prophylaxis was administered at the time of anesthetic induction. The patient was placed in the lithotomy position, followed by meticulous skin preparation and sterile draping. Initial diagnostic urethroscopy was performed to assess the stricture and confirm its location. After endoscope removal, retrograde contrast urethrography was performed to better define the morphological characteristics and length of the stricture. A hydrophilic guidewire was then introduced under fluoroscopic guidance and advanced into the bladder. A small-caliber dilator (CH8) could be used to traverse the stenotic segment and facilitate guidewire passage. The balloon catheter was then advanced over the guidewire and positioned across the stricture, ensuring proximal and distal extension beyond the diseased segment. The balloon was gradually inflated to the recommended pressure using a diluted contrast medium, allowing fluoroscopic monitoring of adequate expansion and the "moulding" effect on the urethral lumen. Dilatation was maintained for three minutes, after which the balloon was deflated and removed under endoscopic control. At the end of the procedure, a CH16 Foley catheter was inserted.

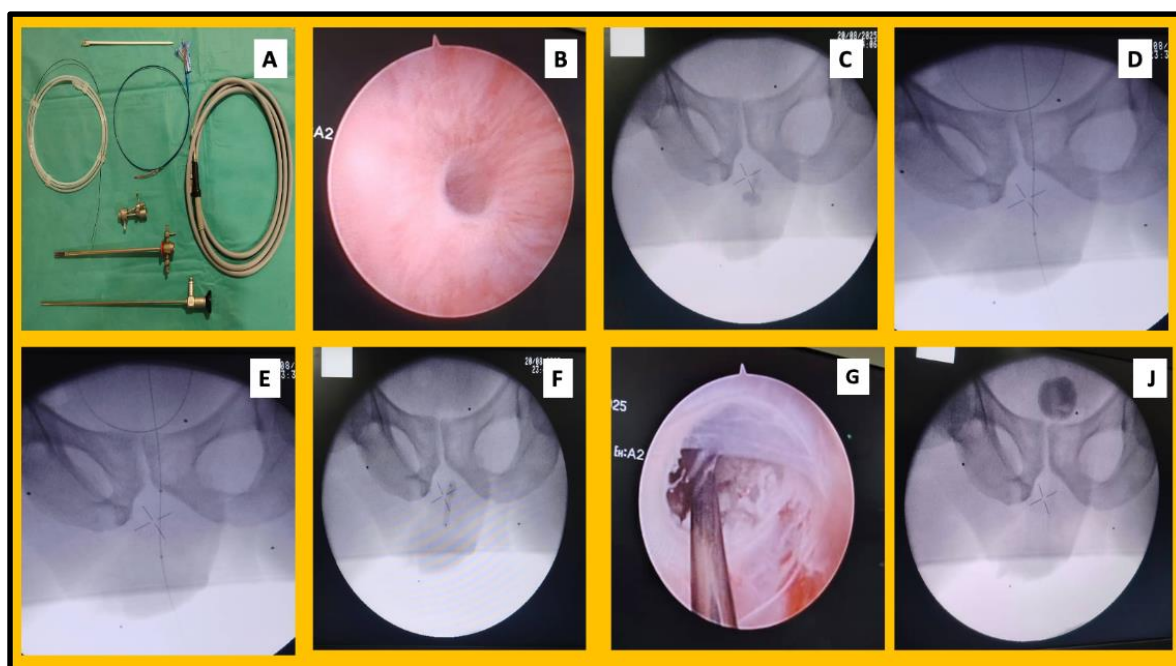


**Figure 1.** Operative setup and procedural step ((A) Operating room setup; (B) initial diagnostic urethroscopy; (C) retrograde urethrography demonstrating a short-segment urethral stricture; (D) passage of a hydrophilic guidewire into the bladder; (E) advancement of the balloon catheter over the guidewire across the stricture; (F) balloon dilation with diluted contrast medium; (G) endoscopic assessment confirming adequate urethral dilation; (H) placement of a Foley catheter with balloon inflated using diluted contrast medium.).

### 2.3. Outcome Measures

Patients were followed according to a standardized protocol including temporary urinary catheterization for 2 days and follow-up visits at 1, 3, and 6 months. The primary outcome was procedural success, defined as the absence of clinical or endoscopic recurrence. Objective functional assessment using uroflowmetry was not available in our institution during the study period, which represents a limitation in standardized outcome evaluation. Consequently, postoperative assessment was based on clinical symptom improvement reported by patients, measurement of post-void residual urine volume, and endoscopic evaluation when clinically indicated in cases of suspected recurrence or persistent symptoms. Secondary outcomes included time to recurrence, postoperative complications, and the need for additional intervention.

### 2.4. Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 29 (IBM Corp., Armonk, NY, USA). Quantitative variables were expressed as absolute values and means, while qualitative variables were presented as frequencies and percentages.

## 3. Results

A total of 30 patients with a single, segmental, and short

urethral stricture were included in this cohort in accordance with the inclusion criteria. The mean age was 36.9 years, ranging from 24 to 102 years.

Symptoms were dominated by obstructive lower urinary tract disorders, primarily dysuria associated with decreased urinary flow ( $n=28$ , 93.3%), which could progress to urinary retention ( $n=6$ , 20%). The mean time from symptom onset to consultation was 9 months. The identified etiologies were: inflammatory in 19 cases (63.3%), traumatic in 7 cases (23.3%), and iatrogenic in 5 cases (13.3%).

Post-void residual urine was assessed in 24 patients (without a suprapubic cystostomy) and was significant ( $>50$  mL) in 36% of cases. At the time of management, 6 patients (20%) had a suprapubic cystostomy.

The bulbous region was the most common site of urethral strictures ( $n=19$ ; 63.3%), followed by the penile region ( $n=8$ ; 26.7%) and the membranous region ( $n=3$ ; 10%). Surgically, urethral dilation was performed under spinal anesthesia in nearly all patients ( $n=29$ ). The mean duration of the procedure was 23 minutes.

In selected patients (ASA score  $\leq 2$  and no major comorbidities), outpatient management was possible, with discharge on the day of the procedure and removal of the urinary catheter on day 2. Postoperatively, two complications were observed: hematuria and sepsis. At the 6-month follow-up, four patients required re-intervention: dilation with a Benique catheter in three cases and internal urethrotomy in one case.

All clinical, etiological, operative, and follow-up characteristics of the patients are summarized in Table 1.

**Table 1.** Clinical, etiological, operative, and follow-up characteristics of the study population.

| Category           | Variables                        | Number (n)          | Percentage (%) |
|--------------------|----------------------------------|---------------------|----------------|
| Epidemiology       | Number of patients               | 30                  | —              |
|                    | Mean age (range)                 | 36.9 years (24-102) | —              |
| Symptomatology     | Dysuria + decreased urinary flow | 28                  | 93.3           |
|                    | Acute urinary retention          | 6                   | 20             |
| Etiology           | Inflammatory                     | 19                  | 63.3           |
|                    | Traumatic                        | 7                   | 23.3           |
|                    | Iatrogenic                       | 4                   | 13.3           |
| Functional impact  | Post-void residual > 50 mL       | 24                  | 36             |
|                    | Suprapubic cystostomy            | 6                   | 20             |
| Stricture location | Bulbar                           | 19                  | 63.3           |
|                    | Penile                           | 8                   | 26.7           |
|                    | Membranous                       | 3                   | 10             |
| Complications      | Hematuria                        | 1                   | —              |
|                    | Sepsis                           | 1                   | —              |
| 6-month outcomes   | Reintervention required          | 4                   | 13.3           |

## 4. Discussion

Urethral stricture results from a pathophysiological process characterized by progressive fibrosis of the corpus spongiosum (spongiofibrosis), leading to loss of elasticity and narrowing of the urethral lumen [11]. This pathological scarring reduces urethral compliance and results in varying degrees of urinary outflow obstruction [12]. Traditional management options range from conservative treatment to surgical interventions, depending on stricture characteristics such as length, location, etiology, and symptom severity [13]. Among endoscopic techniques, balloon dilation represents one of the available options [14]. Balloon dilators exert a radial force on the stricture, resulting in reduced shear stress and less tissue trauma compared with conventional rigid dilators [15]. Russinovich et al. [16] were the first to report their results, describing the technique as relatively atraumatic and painless, with improved long-term outcomes. Beeder et al. [7] further described it as a safe, well-tolerated procedure, feasible in an outpatient setting and easily mastered by urologists.

In our study, the mean age of patients was 36.9 years, lower than that reported in several published series. This contrasts with Yameogo et al. [17], who reported a mean age of 50.5 years, and the multicenter study from Douala, which reported  $41.5 \pm 20.9$  years [18]. This variability may reflect differences in epidemiological profiles, dominant etiologies, and patient recruitment methods. The wide age range in our cohort (24-102

years) highlights the heterogeneity of urethral stricture disease, although it predominantly affects the working-age population.

An identifiable or suspected etiology was found in 89% of cases, reflecting good clinical characterization of contributing factors. This is consistent with literature data, where trauma, iatrogenic injuries related to instrumentation, infections, and idiopathic forms are the main causes [19]. In the Douala series, iatrogenic causes were predominant (35.1%), followed by trauma (25.8%) and infection (23.8%) [18], whereas Yameogo et al. reported a predominance of infectious causes (71.4%) [17]. These differences highlight the heterogeneity of etiological patterns across settings, influenced by healthcare access, endourological practice, and infection prevalence. Overall, infectious causes remain more frequent in African and Maghreb countries [20].

The mean delay to consultation in our series was 9 months, longer than that reported by Yameogo et al. (approximately 6 months) [17]. This diagnostic delay may contribute to more advanced disease at presentation and chronic obstruction. Clinically, patients were mainly symptomatic with obstructive lower urinary tract symptoms, particularly dysuria and reduced urinary flow, consistent with literature findings. Dysuria remains the most frequently reported symptom, observed in 74.2% of cases in the Douala series [18] and 66.7% in the Ouagadougou series [17]. The predominance of obstructive symptoms reflects the mechanical nature of urethral narrowing.

In our cohort, 20% of patients required suprapubic cystostomy, reflecting complicated presentations. Similarly, 36%

had a significant post-void residual urine volume, indicating established bladder dysfunction. These findings are consistent with the pathophysiological progression of urethral stricture disease, which may lead to urinary retention, recurrent infections, bladder stones, and upper urinary tract deterioration in advanced stages [21]. Moreover, disease severity at presentation may influence outcomes, as infectious etiologies and prior endoscopic interventions have been associated with higher recurrence rates.

[22] Stricture length is a key determinant of balloon dilation success, with better outcomes observed in short strictures. Reported success rates reach 85.7% for strictures  $\leq 1$  cm [23] and range between 66-74% for lesions up to 3 cm depending on studies [24-26]. These findings emphasize the importance of careful patient selection.

Balloon urethral dilation is a simple, reproducible, and minimally invasive endoscopic technique, particularly suitable for short urethral strictures as an alternative or bridge to urethroplasty. Its main advantage lies in its low tissue trauma, reducing secondary spongiosclerosis and improving tolerance [27, 28]. Drug-coated balloons, particularly those impregnated with paclitaxel, have recently shown potential in reducing retreatment rates in recurrent strictures [24].

In our series, balloon dilation resulted in early clinical improvement, with improved urinary flow and reduced post-void residual volume. These results are consistent with literature data showing better outcomes of endoscopic techniques in short and bulbar strictures with limited spongiosclerosis [5]. Comparative studies have shown an 84% stricture-free rate after balloon dilation versus 22% after internal urethrotomy, with longer recurrence-free intervals in favor of balloon dilation [1]. However, long-term outcomes remain variable. In a cohort of 56 patients, 3-year stricture-free survival was 35.5% after balloon dilation [29], highlighting the decline in efficacy over time.

In our series, the complication rate was low (6.7%), including one case of hematuria and one case of sepsis. At 6 months, the recurrence rate was 13.3%, requiring reintervention (repeat dilation or internal urethrotomy). These results are consistent with short-term outcomes reported in the literature, where a significant proportion of patients remain symptom-free without early retreatment.

This study represents one of the largest reported African experiences of fluoroscopy-guided balloon dilation for urethral strictures. However, as emphasized in the literature, recurrence is influenced by multiple prognostic factors, including stricture length, location, and degree of spongiosclerosis, limiting long-term durability [24].

## 5. Conclusion

This initial experience of fluoroscopy-guided balloon urethral dilation in our setting demonstrates the feasibility and relevance of this technique in the management of short urethral strictures. Simple, rapid, minimally invasive, and reproducible, it provides satisfactory early clinical outcomes with a

moderate short-term recurrence rate. Beyond encouraging functional results, this series supports balloon dilation as a valuable endourological option within a graded therapeutic strategy, particularly for selected strictures. Its simplicity and safety make it a realistic alternative in resource-limited settings with a high burden of urethral stricture disease. From a broader perspective, wider adoption of this technique could help harmonize management practices and improve access to minimally invasive urethral reconstruction, especially in low-resource environments.

## Abbreviations

|        |                                                                      |
|--------|----------------------------------------------------------------------|
| ASA    | American Society of Anesthesiologists                                |
| mL     | Milliliter                                                           |
| STROBE | Strengthening the Reporting of Observational Studies in Epidemiology |
| YAG    | Yttrium-Aluminum-Garnet (holmium: YAG Laser)                         |

## Author Contributions

**Saleh Abdelkerim Nedjim:** Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft

**Mahamat Ali Mahamat:** Investigation, Writing – review & editing

**Ndormadjita Allah-Syengar:** Data curation, Investigation, Writing – review & editing

**Adoumadji Kouldjim:** Data curation, Investigation, Methodology, Writing – review & editing

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**Nisso Ouang-Kakake:** Investigation, Resources

**Freddy Rimtebaye Kimassoum:** Investigation, Writing – review & editing

**Valentin Vadandi:** Validation, Writing – review & editing

**Rimtebaye Kimassoum:** Supervision, Validation

## Conflicts of Interest

The author declares no conflicts of interest.

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