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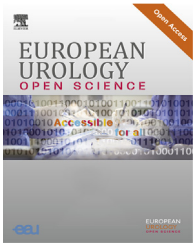

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Endoscopic Management of Adult Primary Obstructive Megaureter: Techniques and Long-term Outcomes

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Abstract

Background and objective: Few studies on endoscopic management of primary obstructive megaureter (POM) in adult patients have been reported. Our objective was to describe our technique and long-term outcomes for endoscopic management of adult POM.

Methods: We included 76 adult POM patients undergoing endoscopic management between September 2015 and January 2024. Under endoscopic control, the stricture was dilated to 24–30 Fr while maintaining a balloon pressure of 25–35 atm for 3 min. An additional incision of the stenotic ring using either an electrode or holmium laser was performed in 39 patients. Data for patient characteristics, intraoperative variables, surgical complications, and follow-up results were analyzed. A descriptive statistical analysis was performed. Surgical success was defined as no tubes or stents in the body, stable or improved symptoms and renal function, and the absence of reflux or obstruction during the follow-up period.

Key findings and limitations: All procedures were completed without conversion to open or laparoscopic surgery. The median operative time was 45 min (range 16–165) with median estimated blood loss of 2 ml (range 0–150). The median postoperative hospital stay was 3 d (range 1–15). No intraoperative complication occurred. At median postoperative follow-up of 42 mo (range 3–100) the overall success rate was 92.1%. Restenosis of the vesicoureteral junction (Clavien-Dindo grade III) occurred in five patients (6.6%), and high-grade vesicoureteral reflux occurred in one patient (1.3%), all of whom required secondary reconstruction surgery.

Conclusions and clinical implications: The results indicate that our endoscopic management for adult POM is safe and effective, with favorable long-term outcomes. This approach could potentially serve as a first-line treatment option for adult POM.

Patient summary: Primary obstructive megaureter (POM) occurs when the flow of urine is blocked because of a narrow segment in the tube between the kidney

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and bladder (ureter), which causes widening of the ureter further up. For our minimally invasive technique, a telescope is inserted through the urethra and bladder to reach the ureter for surgical treatment. Our results show that this is a safe procedure for POM in adults.

1. Introduction

Primary obstructive megaureter (POM) is a congenital anomaly of the ureter characterized by an aperistaltic segment in the distal ureter [1]. POM occurs more commonly among neonates and young children. Adult POM commonly occurs in the third or fourth decade of life, and active management is more strongly recommended as growth and maturation of the vesicoureteral junction (VUJ) are complete [1,2]. Ureteral reimplantation (UR), with or without ureteral tapering, is a well-established treatment for symptomatic POM [3,4]. Laparoscopic and robotic UR techniques have demonstrated commendable success rates exceeding 90%, comparable to those achieved via an open approach [5,6] but can be technically demanding and associated with significant complications and greater invasiveness.

Endoscopic treatment of POM using high-pressure balloon dilation or endoureterotomy has emerged as a viable technique, yielding good results and outcomes similar to UR [7]. Many pediatric urologists now recognize endoscopic balloon dilatation (EBD) as a first-line treatment for pediatric POM [8–10]. For adult patients, endoscopic management is also attractive, but reports are scarce and the clinical efficacy is uncertain [11,12]. Furthermore, few studies have focused on the utility and long-term outcomes of EBD in combination with endoureterotomy [13–16].

To improve the minimally invasive technique for management of adult POM, our center has implement endoscopic management. Here, we report our technique and long-term outcomes for endoscopic management for adult POM.

2. Patients and methods

A total of 76 adult patients with POM who underwent endoscopic management between September 2015 and January 2024 in four different institutions were included. Diagnosis of POM was confirmed via clinical signs and symptoms, a diuretic renogram, and radiographic images. Patients diagnosed with refluxing megaureters and secondary obstructive megaureters were excluded from the study. Surgical intervention was indicated for cases presenting with recurrent or intolerable symptoms, impairment of renal function, and progressive worsening of hydroureteronephrosis (HUN). All the procedures were performed by experienced surgeons.

Patient characteristics, intraoperative variables, surgical complications, and follow-up results were obtained from our prospectively maintained Reconstruction of Urinary Tract: Technology, Epidemiology and Result (RECUTTER) database. Intraoperative and perioperative complications were assessed according to the Clavien-Dindo (CD) classification.

2.1. Preoperative preparation

Computed tomography urography (CTU) was performed in all patients. CTU three-dimensional (3D) reconstruction models offer enhanced anatomic visualization of the urinary tract and vessels. Functional cine magnetic resonance urography (MRU) was used to assess dynamic peristalsis of the ureter. In cases with severe HUN, double-J (DJ) stents or nephrostomy catheters may be necessary.

2.2. Surgical technique

2.2.1. Ureteroscope introduction

Under general anesthesia, the patient is placed in the lithotomy position. An 8/9.8 Fr ureteroscope is introduced to visualize the bladder and bilateral ureteral orifices. Pre-existing DJ stents can be removed under direct vision. A smooth flexible guide wire is then inserted through the affected ureteral orifice (Fig. 1A) to guide retrograde insertion of the ureteroscope past the stenotic VUJ and into the ureter.

2.2.2. Ureteroscopy and stricture length estimation

The lumen of the affected ureter is carefully examined (Fig. 1B). The length of the stricture is estimated as follows: (1) the lens is positioned at the uppermost point of the stricture; (2) the surgeon fixes a finger on the ureteroscope at the urethral orifice; (3) the ureteroscope is withdrawn until it fully passes the stricture; and (4) the distance between the surgeon's finger and the urethral orifice is estimated.

2.2.3. Balloon dilatation

After withdrawing the ureteroscope while keeping the guide wire in place, the balloon dilator (diameter 6 mm, length 6 cm, 18 Fr; BARD X-FORCE U30) is advanced through the stricture. The balloon is positioned to cover the entire stricture, leaving 2 cm below the distal end on the basis of prior estimation. The stricture is dilated to 24–30 Fr, maintaining a balloon pressure of 25–35 atm for 3 min (Fig. 1C).

2.2.4. Endoureterotomy

In 39 cases in which the stenotic ring at the VUJ persisted after EBD, endoureterotomy was performed. The balloon was deflated and left in position. A monopolar Collin's knife electrode or holmium laser fiber is carefully inserted through the ureteroscope and a longitudinal incision is made at the 12-o'clock position using the electrode (25 W) or holmium laser until the full thickness of the ureteric muscular layer is exposed (Fig. 1D). The length of incision is approximately half the estimated length of the stricture.

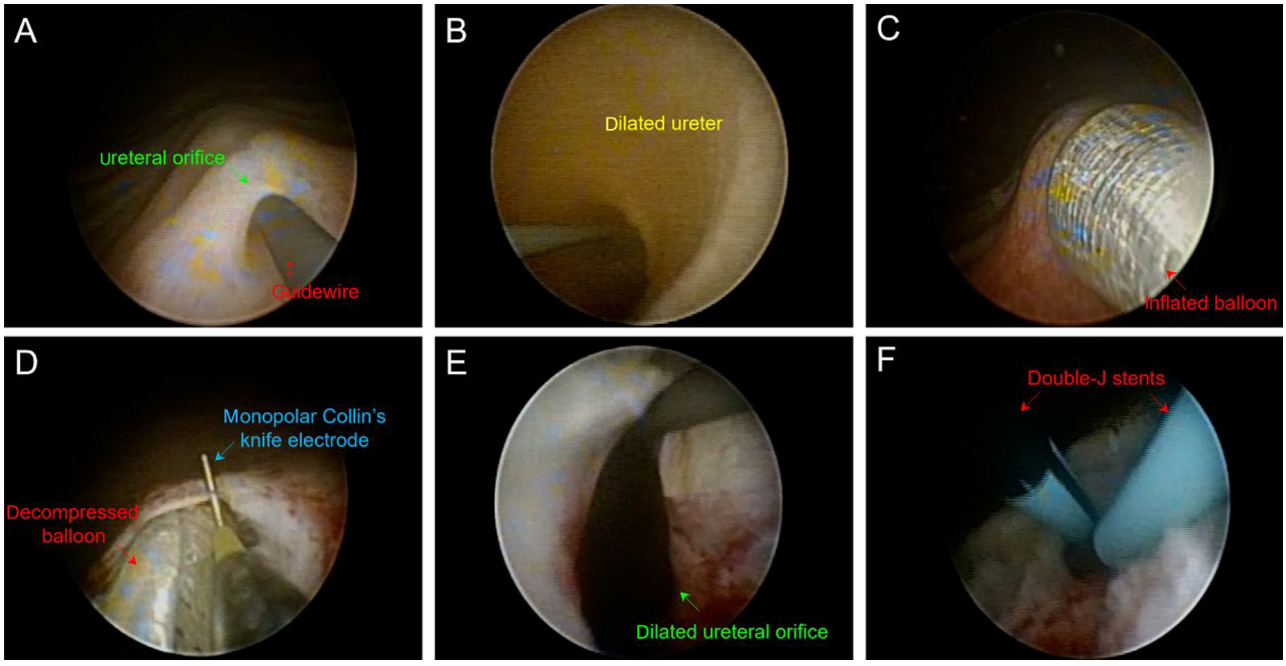

Fig. 1 – Steps in the surgical technique for endoscopic management of adult primary obstructive megaureter. (A) The guide wire is inserted through the affected ureteral orifice. (B) The dilated ureter is examined under ureteroscopic vision. (C) The balloon is inflated to dilate the stricture. (D) Endoureterotomy is performed using a monopolar Collin's knife electrode. (E) Ureteroscopic re-examination of the ureter. (F) Two double-J stents were inserted via guide wires.

2.2.5. *Stent insertion*

Following ureteroscopic re-examination (Fig. 1E), repeat dilatation can be performed if necessary. Two or three DJ stents are inserted via guide wires (Fig. 1F). The stent number and size for optimal urinary drainage are determined according to intraoperative assessment of the ureter length and diameter. Finally, a Foley catheter is inserted.

2.3. *Postoperative treatment and follow-up*

The Foley catheter was routinely removed on postoperative day 1, and DJ stents were typically removed 2 mo postoperatively. Patients underwent regular follow-ups every 3 mo in the first year after surgery and every 6 mo thereafter. Functional cine MRU was performed 3 mo after surgery. Diuretic renal dynamic imaging and CTU with 3D images were performed every 6 mo in the first year postoperatively and then every 1 yr thereafter. Surgical success is defined as no tubes or stents in the body, stable or improved symptoms and renal function, as well as absence of reflux or obstruction during the follow-up period.

3. Results

The baseline characteristics of the patients are summarized in Table 1. Thirty patients (43.6%) were asymptomatic. Flank pain was the most commonly reported symptom (52.6%). Concomitant urolithiasis was observed in 29 cases (38.2%). Concomitant urinary anomalies included four ectopic ureters (5.3%), three duplicate kidneys and ureters (3.9%), three ureteropelvic junction obstruction (3.9%), two solitary kidneys (2.6%), one horseshoe kidney (1.3%), and one renal dysplasia (1.3%). Twenty patients (26.3%) had a preoperative history of urinary tract infection (UTI).

Table 1 – Patient characteristics and preoperative findings

Parameter	Result
Patients (*n*)	76
Sex, *n* (%)	
Male	19 (25.0)
Female	57 (75.0)
Median age, yr (range)	30 (18–75)
Mean body mass index, kg/m^2 (standard deviation)	22.7 (3.3)
Megaureter laterality, *n* (%)	
Left	37 (48.7)
Right	25 (32.9)
Bilateral	14 (18.4)
Symptoms, *n* (%)	
Asymptomatic	30 (39.5)
Flank pain	40 (52.6)
Fever	7 (9.2)
Hematuria	4 (5.3)
Bladder irritation	4 (5.3)
Concomitant urolithiasis, *n* (%)	29 (38.2)
Concomitant urinary anomalies, *n* (%)	
Ectopic ureter	4 (5.3)
Duplicate kidneys and ureters	3 (3.9)
Ureteropelvic junction obstruction	3 (3.9)
Solitary kidney	2 (2.6)
Horseshoe kidney	1 (1.3)
Renal dysplasia	1 (1.3)
Preoperative history of urinary tract infection, *n* (%)	20 (26.3)
History of stent insertion, *n* (%)	15 (19.7)
History of EBD or endoureterotomy, *n* (%)	14 (18.4)
History of ureteral reimplantation, *n* (%)	5 (6.6)
History of percutaneous nephrostomy, *n* (%)	1 (1.3)

EBD = endoscopic balloon dilatation.

Intraoperative details and follow-up results are presented in Table 2. A total of 37 patients (48.7%) underwent EBD, and 39 (51.3%) underwent EBD followed by endoureterotomy. Six (7.9%) patients underwent additional ureteroscopic lithotomy, and one (1.7%) patient underwent additional transurethral middle-lobe prostatectomy. The

Table 2 – Intraoperative details and follow-up results

Parameter	Result
Surgical procedure, *n* (%)	
Endoscopic balloon dilatation	37 (48.7)
Endoscopic balloon dilatation + endoureterotomy	39 (51.3)
Electrocautery incision	29 (38.1)
Holmium laser incision	10 (13.2)
Additional endoscopic procedures, *n* (%)	
Ureteroscopic lithotomy	6 (7.9)
Transurethral middle prostatectomy	1 (1.3)
Median operative time, min (range)	45 (16–165)
Estimated blood loss (ml), median (range)	2 (0–150)
Median postoperative hospital stay, d (range)	3 (1–15)
Intraoperative complications (*n*)	0
Postoperative complications, *n* (%)	
Cystospasm (CD grade I)	5 (6.6)
Fever (CD grade I)	1 (1.3)
Urinary tract infection (CD grade II)	8 (10.5)
Restenosis of the vesicoureteral junction (CD grade III)	5 (6.6)
High-grade vesicoureteral reflux (CD grade III)	1 (1.3)
Median follow-up, mo (range)	42 (3–100)
Success rate (%)	92.1

CD = Clavien-Dindo.

median operative time was 51 min (range 25–165) with a median estimated blood loss of 2 ml (range 0–150). The median postoperative hospital stay was 3 d (range 1–15).

All procedures were completed without conversion to open or laparoscopic surgery and no intraoperative complication occurred. Postoperative complications of CD grade I included cystospasm in five patients (6.6%) and fever in one patient (1.3%), all of whom recovered after supportive care treatment. UTI (CD grade II) occurred in eight patients (10.5%) and recovered after oral antibiotics. Five patients (6.6%) experienced restenosis of the VUJ (CD grade III) at 3, 12, 12, 36, and 60 mo after surgery, respectively. One patient (1.3%) developed high-grade vesicoureteral reflux (VUR; CD grade III) at 24 mo after surgery. These six patients underwent subsequent endoscopic or robotic reconstruction, and symptoms and hydronephrosis resolved at their last follow-up visit. At a median postoperative follow-up of 42 mo (range 3–100), 70 patients had relieved or stable symptoms, improved HUN (Fig. 2), and preserved renal function, resulting in a success rate of 92.1%.

4. Discussion

Treatment of adult POM presents distinct challenges in comparison to pediatric cases, as spontaneous regression is less common among adults. Prolonged subclinical damage in adults can lead to severe complications and irreversible loss of renal function, so there is a need for more proactive intervention strategies [17].

Laparoscopic UR has gained in popularity owing to its benefits over open surgery, including better cosmetic outcomes, lower morbidity, and faster recovery times [18,19]. The advent of robotic platforms has further enhanced these benefits by offering better 3D vision, greater surgical dexterity, and superior camera control, thereby facilitating intricate procedures such as urinary tract reconstructions, which are challenging owing to their complexity and the confined working space [1]. Various modifications to the traditional laparoscopic techniques have been explored, from intracorporeal suturing to ureteroneocystostomy with antireflux techniques, to optimize outcomes [1,20]. Our experience with modified laparoscopic UR with extracorporeal tailoring and intracorporeal direct nipple ureteroneocystostomy resulted in lower estimated blood loss, less of a need for narcotic analgesics, and shorter hospital stays in comparison to an open surgical approach [20,21]. Building on this, we successfully implemented robotic UR with totally intracorporeal tailoring and direct nipple ureteroneocystostomy, which yielded similarly positive outcomes.

Despite these advances, UR remains a technically demanding procedure requiring surgeons with specialized skills. UR is also inherently invasive and is associated with potential complications. Endoscopic management represents an advantageous alternative owing to its reduced technical demands and faster patient recovery times [8,9]. EBD was first introduced for pediatric POM by Angulo et al in 1998 [22] and has been recognized as a first-line treatment in children, with success rates between 46% and 100% reported after the initial dilatation [1]. However, there is a paucity of research on EBD in adult POM, highlighting a significant gap in the literature and need for further investigation [13,14].

It is believed that POM stems from a functional obstruction due to abnormal development of ureteral muscles and collagen fibers [23]. Disappearance of the stenotic ring after EBD suggests an anatomic obstruction at the VUJ rather than a purely functional obstruction [1]. Bapat et al [11] performed endoureterotomy for POM in five adults in 2000, using electrocautery incisions at the stenotic VUJ. This technique was also applied in pediatric cases, with success rates of ~90% and minimal complications [24,25]. Biyani and Powell [12] introduced holmium laser for endoscopic incision in adult POM cases. Endoureterotomy with holmium laser incision and cutting balloon ureterotomy following EBD has also been performed for pediatric POM [16,26]. However, limited sample sizes in these studies and lack of data for adult populations hinder the assessment of outcomes in adult patients.

Our study represents the first comprehensive series evaluating the safety and feasibility of endoscopic management for adult POM. The median operative time was 51 min with a median estimated blood loss of 2 ml. The median postoperative hospital stay was 3 d, which is longer than in previous studies on endoscopic POM management in pediatric patients. This disparity in hospital stay may be influenced by variations in health care and medical insurance systems across different nations and hospitals. Longer non-essential hospitalization was observed across four different institutions, despite our standard practice of removing the Foley catheter on postoperative day 1 and the satisfactory complication profiles during hospitalization.

The overall success rate was 92.1% in our study at long-term follow-up. The major postoperative concerns are potential recurrence of obstruction and the development of iatrogenic VUR [27]. We added endoureterotomy for 39 of our cases because the stenotic ring in the VUJ persisted after EBD. We incised half of the total length of the stricture to prevent postoperative obstruction or VUR, regardless of cutting modality. Restenosis of the VUJ occurred in five patients (3, 12, 12, 36, and 60 mo after surgery, respec-

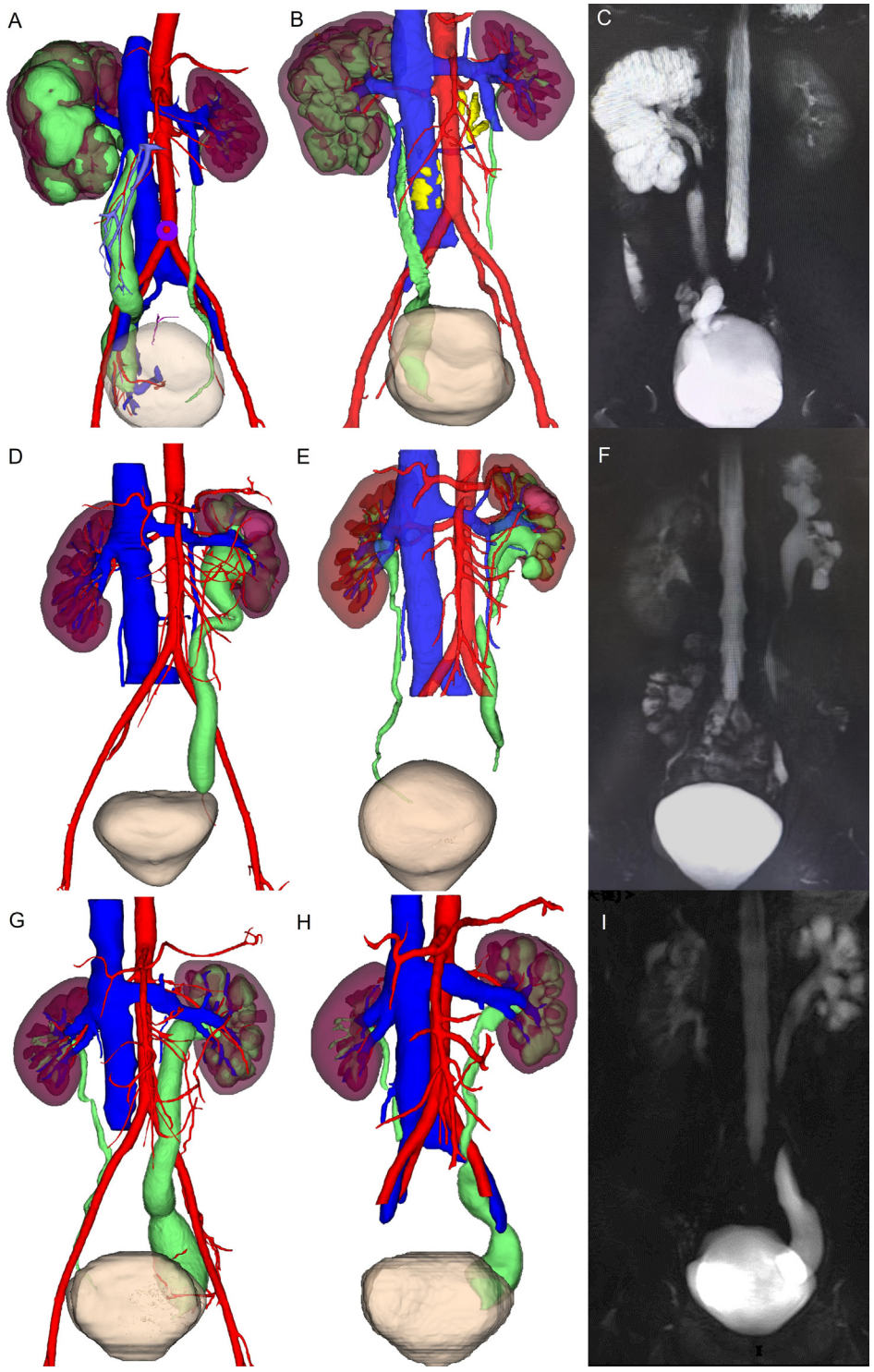

Fig. 2 – Preoperative and postoperative imaging for three patients primary obstructive megaureter who underwent endoscopic treatment. (A, D, G) Preoperative and (B,E, H) postoperative three-dimensional computed tomography urography images. (C, F, I) Postoperative cine magnetic resonance urography images.

tively) and high-grade VUR in one patient (24 mo after surgery) and they required secondary endoscopic or robotic reconstruction. All symptoms and hydronephrosis resolved at the last follow-up visit. These results and complication profiles are similar to those reported for endoscopic management in a pediatric population [1].

Previous studies predominantly conducted EBD under fluoroscopic guidance, which has potential for radio-induced adverse effects that should not be disregarded and could be avoidable. Casal Beloy et al [28] and Ortiz et al [9] described EBD under direct visualization without fluoroscopic assistance for POM. Ortiz et al [29] compared

two groups of POM patients treated with EBD, one using fluoroscopy and the other without, and found no significant differences in complications rates or long-term outcomes. Our radiation-free endoscopic approach minimizes the risks associated with radiation exposure. Visualization of the distance between a finger and the urethral orifice during ureteroscope retraction allows the surgeon to estimate the stricture length. The guide wire and the deflated balloon in situ play pivotal roles in preventing iatrogenic injuries under direct visualization. We propose that endoscopic management without fluoroscopic control holds promise as a technique for adult POM treatment, although further validation of its indications and safety is warranted.

Limitations of our study primarily stem from the relatively modest sample size and the retrospective design, although our findings represent the largest series to date on endoscopic POM management for adult patients. In addition, we did not compare outcomes between endoscopic management and UR. The potential for endoscopic management to replace traditional approaches in adult patients remains uncertain [13,14,30]. In our experience, traditional UR remains the standard treatment for cases with considerable ureteral dilatation with obvious tortuosity, as ureteral peristalsis suffered a lot, and endoscopic management may not be appropriate. Few studies have compared outcomes between endoscopic treatment and UR. García-Aparicio et al [30] compared 13 POM cases treated with EBD and 12 treated with open UR in a pediatric population, and found no significant differences in improvements in HUN, postoperative VUR, or secondary UR rates. A meta-analysis also indicated similar clinical efficacy (92% vs 92%) and complication rates (6.1% vs 12.0%) for EBD versus UR for POM, although there was significant heterogeneity (I^2 = 54.9%) among the UR studies [14]. Nevertheless, in line with the principle of minimal invasiveness, we advocate for consideration of endoscopic management as an initial approach for adults with POM. Cases of postoperative restenosis or VUR can be addressed via repeat endoscopic procedures or laparoscopic/robotic UR. Larger prospective randomized controlled trials are needed to establish endoscopic management as a viable alternative to UR in adult POM.

5. Conclusions

Our results demonstrate that endoscopic management is a safe and effective treatment for adult POM with satisfactory long-term outcomes and limited complications. This approach may be considered as a first-line treatment for adult POM. However, larger prospective randomized controlled trials are essential in the future.

***Author contributions*:** Xuesong Li had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: G. Wang, Xuesong Li.
Acquisition of data: Zhenyu Li, Yang, Du.
Analysis and interpretation of data: Zhenyu Li, Yang, Du, Xinfei Li, Zhihua Li, B. Wang, Huang.
Drafting of the manuscript: Zhenyu Li, Yang, Du.
Critical revision of the manuscript for important intellectual content: Zhenyu Li, Yang, Du, Chen, Y. Zhang, Zhu, P. Zhang.
Statistical analysis: Zhenyu Li, Yang, Du, Zhu, P. Zhang, Zhou.
Obtaining funding: Kunlin Yang.
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Supervision: G. Wang, Xuesong Li.
Other: None.

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***Data sharing statement*:** Data are available for bona fide researchers on request from the authors.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.euros.2024.08.005.

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