Pneumovesicoscopic Ureteral Reimplantation for Pediatric Vesicoureteral Reflux: Politano-Leadbetter versus Cohen Technique

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Abstract

Purpose

To investigate and compare the clinical efficacy of pneumovesicoscopic Politano-Leadbetter and Cohen techniques in the treatment of primary vesicoureteral reflux (VUR) in children.

Methods

A retrospective analysis was conducted on 162 children with primary VUR (grades III-V) who underwent pneumovesicoscopic ureteral reimplantation. Patients were divided into Politano-Leadbetter group (Group P, n = 88) and Cohen group (Group C, n = 74), including 107 unilateral and 55 bilateral cases. Operative parameters and complications over a 6–30 months follow-up were compared.

Results

All procedures were completed successfully without conversion to open surgery. For unilateral reflux, there were no significant differences between Group P and Group C in terms of operative time (118.62 ± 28.97 vs. 114.34 ± 21.13 min, $p = 0.405$), estimated blood loss (6.09 ± 0.97 vs. 5.95 ± 0.88 ml, $p = 0.438$), duration of urethral catheterization (4.26 ± 0.57 vs. 4.44 ± 0.84 days, $p = 0.187$), hospitalization (6.29 ± 1.69 vs. 6.37 ± 0.92 days, $p = 0.798$), and incidence of complications (6.6% vs. 13.0%, $p = 0.236$). Similarly, no significant differences in these parameters were observed in patients with bilateral reflux (all $p > 0.05$). The overall success rate exceeded 98% in both groups.

Conclusion

Pneumovesicoscopic ureteral reimplantation is a safe and effective minimally invasive approach for pediatric VUR. Although the Politano-Leadbetter technique is more technically complex, it provides a more physiological ureteral path. Long-term outcomes require further validation.

Introduction

Primary vesicoureteral reflux (VUR) is a common congenital anomaly of the urinary system in children, with a reported incidence of 1%- 2% across different studies [1]. This condition frequently predisposes affected children to upper urinary tract infections and the development of renal scarring [2]. Although open ureteral reimplantation comprises a variety of techniques and continues to demonstrate favorable therapeutic outcomes [3, 4], the past two decades have seen considerable evolution in surgical practice toward minimally invasive approaches. As a result, laparoscopic, robotic-assisted, and pneumovesicoscopic ureteral reimplantation have gained increasing adoption worldwide [5–8]. These

minimally invasive techniques achieve efficacy comparable to that of open surgery while providing benefits such as reduced tissue trauma and accelerated recovery [9].

Previous studies have mainly focused on comparing outcomes between open surgery and individual minimally invasive techniques [10]. However, there remains limited literature directly comparing the anatomical reconstruction effectiveness and mid-term prognosis of the pneumovesicoscopic Cohen and Politano-Leadbetter procedures for primary VUR.

In this retrospective study, we analyzed 162 pediatric patients with primary VUR (grades III–V) who underwent pneumovesicoscopic ureteral reimplantation. Operative parameters and complications during a follow-up period of 6 to 30 months were evaluated to compare the clinical outcomes of the pneumovesicoscopic Politano-Leadbetter and Cohen techniques. Additionally, we present our experience regarding the identification of key anatomical landmarks, with the aim of simplifying the technical challenge associated with extravesical ureteral dissection during the Politano-Leadbetter procedure.

Materials and Methods

Study design

This retrospective study included 162 pediatric patients who underwent pneumovesicoscopic ureteral reimplantation at our institution between October 2021 and January 2024. The inclusion criteria were: (1) diagnosis of primary VUR, with reflux grade IV–V confirmed by voiding cystourethrography (VCUG) or contrast-enhanced ultrasound; (2) grade III reflux accompanied by breakthrough febrile upper urinary tract infections despite continuous antibiotic prophylaxis; and (3) differential renal function (DRF) of the affected kidney below 40% or showing a significant decline. Patients were excluded if they had concomitant upper urinary tract anomalies, such as ureteral stenosis, significant dilation, or duplex collecting systems, as well as cases of secondary VUR due to underlying lower urinary tract pathologies (e.g., posterior urethral valves or neurogenic bladder). Among the included patients, 88 were treated using the Politano-Leadbetter technique (Group P) and 74 underwent the Cohen procedure (Group C). Baseline demographic and clinical characteristics of the two groups are presented in Table 1.

Table 1
Comparison of the characteristics of pediatric patients undergoing ureteral reimplantation between the Politano-Leadbetter and Cohen techniques

Variables	Group P (Politano-Leadbetter technique)	Group C (Cohen technique)	*p*
No. of patients	88	74	
Sex			
Male	53	42	
Female	35	32	0.625
Unilateral	61	46	
Bilateral	27	28	0.338
Age (months), mean ± SD	60.98 ± 7.55	63.29 ± 9.87	0.101
Ureteral diameter (mm), mean ± SD	11.27 ± 4.31	10.98 ± 4.69	0.684
VUR grade			0.459
III	12	14	
IV	63	51	
V	13	9	

Surgical techniques

Under general anesthesia, the patient is positioned in lithotomy posture. A Fr6 or Fr8 disposable catheter is introduced to ensure complete bladder emptying. A cystoscope is then passed transurethrally and connected to a carbon dioxide (CO_2) insufflation system, maintaining an intravesical pressure between 8 and 12 mmHg and flow rate of 3–4 l/min. The bladder dome was identified externally, and two sutures were placed perpendicular to the longitudinal axis of the patient to approximate the bladder wall to the anterior abdominal wall. A 5 mm trocar was inserted percutaneously and secured between these sutures; the laparoscope was introduced through this port to establish a CO_2-pneumovesicum working space. Two additional 3 mm trocars were placed bilaterally under endoscopic guidance as working channels.

Cohen Technique

The approach for Cohen Technique was performed as described by Yeung et al. [6] and Yunli Bi et al. [11]. A circumferential incision was made around the affected ureteral orifice, involving both the mucosal and muscular layers. The ureter was mobilized extravesically along the mesoureteral plane for a distance

of 3–5 cm (adjusted according to ureteral diameter) and then retracted into the bladder through the original hiatus. A new mucosal orifice was created approximately 1–2 cm superolateral to the contralateral ureteral orifice. A 3–5 cm submucosal tunnel was developed between the original and new orifices. The ureter was then drawn through this tunnel and anastomosed to the mucosa of the new orifice using interrupted absorbable sutures. Finally, the muscular and mucosal layers at the original hiatus were reapproximated and closed.

Politano-Leadbetter Technique

With pneumovesicum stabilization, the Politano-Leadbetter technique is performed in a similar manner to that previously described by Choi et al. [12]. Initial distal ureteral mobilization was performed similarly to the Cohen technique. After achieving adequate length, gentle traction on the ureter helps delineate its retrovesical course. Approximately 2–3 cm superior to the original orifice along this path, an incision is made through the bladder mucosa and detrusor to access the extravesical space. The peritoneal reflection is carefully dissected to avoid injury to adjacent structures such as the vas deferens in males or fallopian tubes in females. The ureter is exteriorized through this new detrusor hiatus, with careful release of extravesical connective tissue to prevent kinking or torsion. A longitudinal submucosal tunnel is created from the new hiatus toward the original orifice, and the detrusor muscle at the new hiatus is closed. The ureter is then repositioned through the tunnel and anastomosed to the original orifice using interrupted absorbable sutures; any remaining mucosal defects are closed with a continuous absorbable suture (Fig. 1). If tunnel length is deemed insufficient, additional dissection of the mucosa toward the bladder neck may be performed.

Observation indicators and follow-up

The following parameters were recorded and compared between the two groups: operative time, estimated blood loss, duration of urethral catheterization, hospitalization, and incidence of complications. Postoperative follow-up was conducted at 1, 3, and 6 months postoperatively, and then every 6 months thereafter. Evaluations included VCUG and ultrasonography.

Statistical analysis

Statistical analyses were performed using SPSS software (version 22.0). Measurement data are presented as mean ± standard deviation ($\bar{x}\pm s$) and compared between groups using two-tailed Student's unpaired t tests. Count data are expressed as number (percentage) and were compared using the chi-square tests or Mann-Whitney u tests. Statistical significance was set at probability values of $p < 0.05$.

Results

All 162 patients successfully underwent the pneumovesicoscopic ureteral reimplantation procedure without conversion to open surgery. For patients with unilateral VUR, the operative time was 118.62 ± 28.97 minutes in Group P and 114.34 ± 21.13 minutes in Group C (p = 0.405). The estimated blood loss was 6.09 ± 0.97 mL in Group P and 5.95 ± 0.88 mL in Group C (p = 0.438). The duration of urethral catheterization postoperatively was 4.26 ± 0.57 days in Group P and 4.44 ± 0.84 days in Group C (p = 0.187). The hospitalization was 6.29 ± 1.69 days for Group P and 6.37 ± 0.92 days for Group C (p = 0.798). The incidence of complications was 6.6% in Group P and 13.0% in Group C (p = 0.236) (Table 2.1).

Table 2.1
Comparisons of the peri-and postoperative parameters and Politano-Leadbetter vs. Cohen techniques in unilateral patients

Variables	Group P (Politano-Leadbetter technique)	Group C (Cohen technique)	*p*
No. of patients	61	46	
operative time (minutes)	118.62 ± 28.97	114.34 ± 21.13	0.405
estimated blood loss (mL)	6.09 ± 0.97	5.95 ± 0.88	0.438
duration of urethral catheterization (days)	4.26 ± 0.57	4.44 ± 0.84	0.187
hospitalization (days)	6.29 ± 1.69	6.37 ± 0.92	0.798
complications (case, %)	4(6.6)	6(13.0)	0.236
hemorrhage	1	0	
urinary extravasation	2	5	
febrile urinary tract infections	0	0	
anastomotic obstruction	0	0	
recurrent reflux	0	0	
hydronephrosis	1	1	

For patients with bilateral VUR, the operative time was 153.31 ± 47.57 minutes in Group P and 134.88 ± 37.74 minutes in Group C (p = 0.098). The estimated blood loss was 7.21 ± 1.20 mL in Group P and 6.87 ± 1.32 mL in Group C (p = 0.302). The duration of urethral catheterization was 4.95 ± 2.07 days in Group P and 4.70 ± 1.69 days in Group C (p = 0.637). The hospitalization was 6.97 ± 1.71 days for Group P and 6.68 ± 0.92 days for Group C (p = 0.441). The incidence of complications was 7.4% in Group P and 14.3% in Group C (p = 0.358) (Table 2.2).

Table 2.2
Comparisons of the peri-and postoperative parameters and Politano-Leadbetter vs. Cohen techniques in bilateral patients

Variables	Group P (Politano-Leadbetter technique)	Group C (Cohen technique)	*p*
No. of patients	27	28	
operative time (minutes)	153.31 ± 47.57	134.88 ± 37.74	0.098
estimated blood loss (mL)	7.21 ± 1.20	6.87 ± 1.32	0.302
duration of urethral catheterization (days)	4.95 ± 2.07	4.70 ± 1.69	0.637
hospitalization (days)	6.97 ± 1.71	6.68 ± 0.92	0.441
complications (case, %)	2(7.4)	4(14.3)	0.358
hemorrhage	1	0	
urinary extravasation	0	3	
febrile urinary tract infections	0	0	
anastomotic obstruction	1	0	
recurrent reflux	0	1	
hydronephrosis	0	0	

None of the above differences were statistically significant. All children achieved unobstructed voiding after catheter removal. Follow-up examinations, including VCUG and contrast-enhanced ultrasound, showed improvement in ureteral dilation in both groups compared to preoperative status (Fig. 2).

Analysis of the results is as follows: (1) There were no statistically significant differences between the two groups in terms of gender ratio, age, disease spectrum, or ureteral diameter. (2) The mean operative time in Group P was longer than that in Group C, with a more notable difference in patients with bilateral disease (unilateral: Group P 118.62 ± 28.97 min vs. Group C 114.34 ± 21.13 min; bilateral: Group P 153.31 ± 47.57 min vs. Group C 134.88 ± 37.74 min), although the differences were not statistically significant. (3) For both unilateral and bilateral VUR, no significant intergroup differences were detected in estimated blood loss, catheterization duration, hospitalization, or complication rates.

Discussion

Over the past decade, the management of pediatric primary VUR has gradually shifted toward minimally invasive techniques. Among these techniques, endoscopic injection using bulking agents offers a minimally invasive option suitable for low-grade VUR, but its long-term efficacy beyond five years remains uncertain, and it carries risks of requiring repeated injections or causing ureteral obstruction

[13]. The extravesical Lich-Gregoir technique, including its robotic-assisted variants, demonstrates good efficacy but poses potential risks of pelvic nerve injury, voiding dysfunction, and disturbance to adjacent abdominopelvic organs [14]. In contrast, pneumovesicoscopic intravesical procedures, such as the Cohen and Politano-Leadbetter techniques, offer distinct advantages by avoiding abdominal cavity entry, minimizing surgical trauma, and facilitating near-physiological reconstruction of the ureterovesical junction [1, 10, 15, 16]. While differences exist among various transvesicoscopic methods, their core benefit lies in preserving abdominal integrity and reducing iatrogenic risks, establishing them as a reliable choice for pediatric VUR repair.

With regard to our team's clinical practice experience, our institution began adopting the pneumovesicoscopic Cohen technique in 2019, followed by the introduction of the Politano-Leadbetter procedure in 2020. Initial proficiency of the Cohen technique shortened the learning curve and enhanced surgical confidence for the subsequent adoption of the more complex Politano-Leadbetter procedure. Our data indicated a longer average operative time for the Politano-Leadbetter group, primarily attributable to the challenging step of extravesical ureteral identification and mobilization through the new detrusor hiatus. This step requires proficient laparoscopic skills, a precise understanding of the ureteral course, and familiarity with extravesical anatomy.

Pneumovesicoscopic ureteral reimplantation possesses unique characteristics that afford specific anatomical localization approaches. Unlike the original open Politano-Leadbetter technique, the pneumovesicoscopic approach allows direct visualization through the new hiatus, facilitating more accurate identification of anatomical landmarks and mitigating the difficulty of extravesical ureteral localization—representing a notable refinement of the traditional open approach. To further optimize this step, we summarize the following key points: (1) Vas deferens as a landmark: Near the new hiatus on the posterior bladder wall, the ureter converges with the vas deferens, which then courses medially toward the midline. During extravesical dissection, surgeons must therefore carefully dissect between these structures to avoid injuring the vas deferens. Given its relatively constant and identifiable anatomical position, the vas deferens serves as a reliable extravesical landmark for ureteral localization in male patients (Fig. 3) (2) Peritoneal reflection as a landmark: Accurate identification of the peritoneal reflection is crutial during extravesical dissection. Peritoneal breach risks CO_2 leakage, leading to bladder collapse, increased surgical difficulty, and possible conversion to open procedure. Moreover, when the peritoneal reflection is located inferiorly, the mobilized ureter lies lateral to the peritoneum, providing an additional topographic cue for extravesical ureteral identification. (3) Complete extravesical mobilization: After complete mobilization, the ureter is transposed through the new hiatus into the bladder. This step requires ensuring a tension-free path without kinking. Ureteral kinking or obstruction in the intramural segment is a particular risk, often resulting from an unfavorable detrusor tunnel angle but more frequently from inadequate extravesical tissue release causing tethering. Consequently, meticulous and complete dissection of periureteral tissues is imperative to prevent distortion or angulation.

Postoperative outcomes and complications are essential for evaluating surgical efficacy. Our follow-up data revealed a specific profile of complications associated with pneumovesicoscopic ureteral

reimplantation, mainly including hemorrhage, urinary extravasation, febrile urinary tract infections, anastomotic obstruction, and recurrent reflux. A detailed analysis of complications in both groups is as follows: In unilateral cases, the Politano-Leadbetter group had 2 cases of urinary extravasation (one requiring reoperation for stent replacement), 1 case of postoperative hemorrhage (resolved within 3 days), and 1 case of mild hydronephrosis detected at 12-month follow-up. The Cohen group had 5 cases of urinary extravasation and 1 case of mild hydronephrosis at 6 months that resolved by 18 months. In bilateral cases, the Politano-Leadbetter group had 1 case of postoperative hemorrhage (resolved in 3 days) and 1 case of anastomotic stenosis. The Cohen group had 3 cases of urinary extravasation and 1 case of recurrent reflux. Review of surgical video recordings suggested that anastomotic stenosis in the Politano-Leadbetter group might be attributed to compromised distal ureteral blood flow due to excessive anastomotic tension, whereas recurrent reflux in the Cohen group possibly resulted from over-aggressive dissection damaging ureteral vasculature. Urinary extravasation, which typically peaks around postoperative day 3 due to anastomotic edema or transient stent blockage, usually resolved spontaneously via peritoneal absorption. Associated symptoms (e.g., abdominal pain and delayed flatus) subsided within 5 days in all but one case requiring stent revision. Despite these complications, both techniques achieved excellent short-term outcomes with an overall success rate exceeding 98%, confirming their procedural efficacy.

Based on our experience, the Politano-Leadbetter technique offers several advantages: (1) Its more proximal new hiatus location allows for extended ureteral mobilization, improving exposure for pathological segment resection and facilitating anatomical alignment restoration in tortuous, dilated ureters, thereby reducing kinking risks. (2) More importantly, this technique maintains the ureter in a near-physiological position and preserves the original orifice location, whereas the contralateral translocation of the Cohen technique alters the ureteral course, potentially complicating future endoscopic interventions for upper tract issues. (3) The Politano-Leadbetter approach simplifies submucosal tunnel creation: the tunnel angle aligns more naturally with laparoscopic instrument entry, and the new hiatus position can be adjusted flexibly to achieve an optimal tunnel length-to-diameter ratio. The adaptability of the Politano-Leadbetter technique frequently facilitates the creation of a longer submucosal tunnel, more readily achieving the recommended length-to-diameter ratio of over 5:1 for effective anti-reflux surgery. By contrast, the Cohen technique necessitates dissection within the trigone, where denser tissues and adherent mucosa elevate the risk of perforation; this approach also presents a greater challenge in achieving sufficient tunnel length in markedly dilated ureters. These technical distinctions, coupled with the option to integrate a modified Glenn-Anderson approach for caudal orifice placement, highlight the particular utility of the Politano-Leadbetter method in complex cases.

This study has limitations. Its retrospective design introduces possibility for selection and information bias. The follow-up period of 6–30 months is insufficient to assess long-term outcomes such as late-onset ureteral stricture or progressive renal scarring, which are crutial for validating the proposed advantages of the Politano-Leadbetter technique. Attrition bias due to some loss to follow-up may overestimate efficacy. The sample size, while substantial, may lack the statistical power to detect differences in rarer complications. Although performed by a consistent surgical team, variations in

individual technical proficiency could introduce heterogeneity, and the single-center design limits generalizability. Future multi-center, prospective randomized trials with longer follow-up exceeding five years are warranted to confirm these findings and better establish the long-term profiles of these techniques.

In conclusion, pneumovesicoscopic ureteral reimplantation represents an effective and safe minimally invasive approach for treating pediatric VUR in the short-term, characterized by minimal trauma and rapid recovery. Specifically, the Politano-Leadbetter technique, while potentially more technically demanding, offers advantages including a more physiological ureteral position and the ability to create a longer, more effective anti-reflux tunnel, making it a valuable technique worthy of broader consideration and adoption.

Declarations

Ethics approval and consent to participate

The studies involving humans were approved by Ethics Committee of Children’s Hospital of Suzhou University (Ethics Number: 2025CS107). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants’ legal guardians/next of kin in accordance with the national legislation and institutional requirements. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Consent for publication

Not Applicable.

Availability of data and materials

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Competing interests

The authors declare no competing interests.

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Authors' contributions

Mingliu Huang contributed to conceptualization, data curation, writing – original draft and software; Chao Wang, Shu Dai and Hongliang Xia contributed to supervision, writing – review and editing, validation and software; Xu Cao and Mingcui Fu contributed to investigation and methodology; Yun Zhou, Xiangming Yan and Yunli Bi contributed to resources and visualization; Ting Zhang conceived the study concept, supervised the project and gave approval of the final version of this work. All authors read and approved the final manuscript.

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Figures

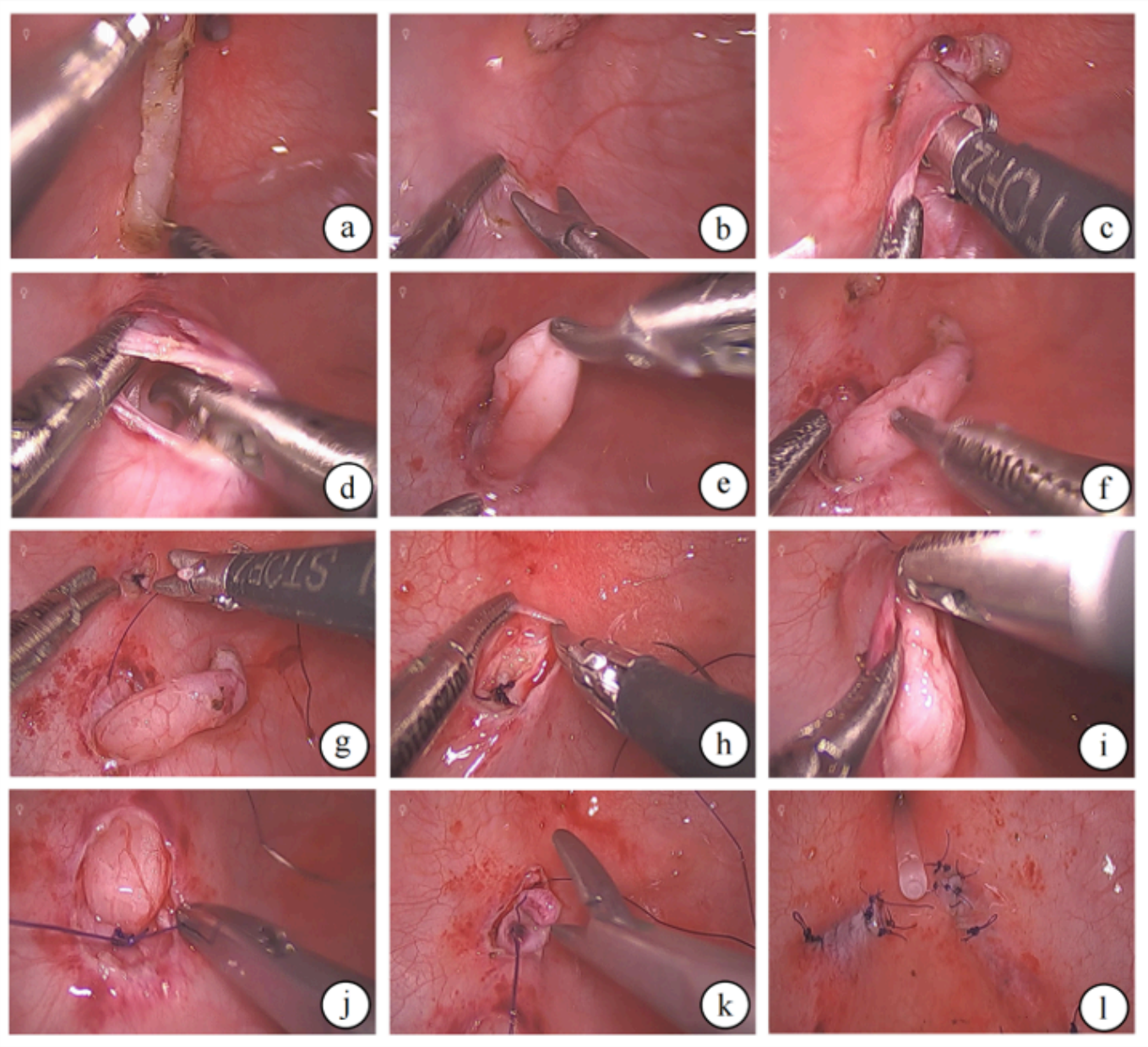

Figure 1

Surgical procedure of the Politano-Leadbetter technique for VUR. **a** The ureter is mobilized. **b** An incision is made in the bladder mucosa approximately 3 cm superior to the original ureteral orifice, following the projected course of the ureter. **c** A submucosal tunnel is created from the new hiatus toward the original orifice. **d** The detrusor muscle layer inferior to the new hiatus is dissected to access the extravesical space, with careful release of surrounding soft tissues to facilitate ureteral identification. **e**Under direct visualization, the ureter is drawn into the bladder through the new hiatus. **f** The ureter is checked to ensure absence of kinking or torsion caused by adjacent tissue traction. **g** The detrusor muscle at the original orifice is reapproximated, and tunnel length is assessed. **h** If needed, the mucosal plane is further dissected from the original orifice toward the bladder neck to extend tunnel length. **i** The ureter is passed through the submucosal tunnel. **j** The detrusor defect at the new hiatus is closed, with proximal fixation of the ureter. **k** The distal ureteral mucosa is anastomosed to the bladder mucosa with interrupted sutures. **l**Final appearance following bilateral ureteral fixation

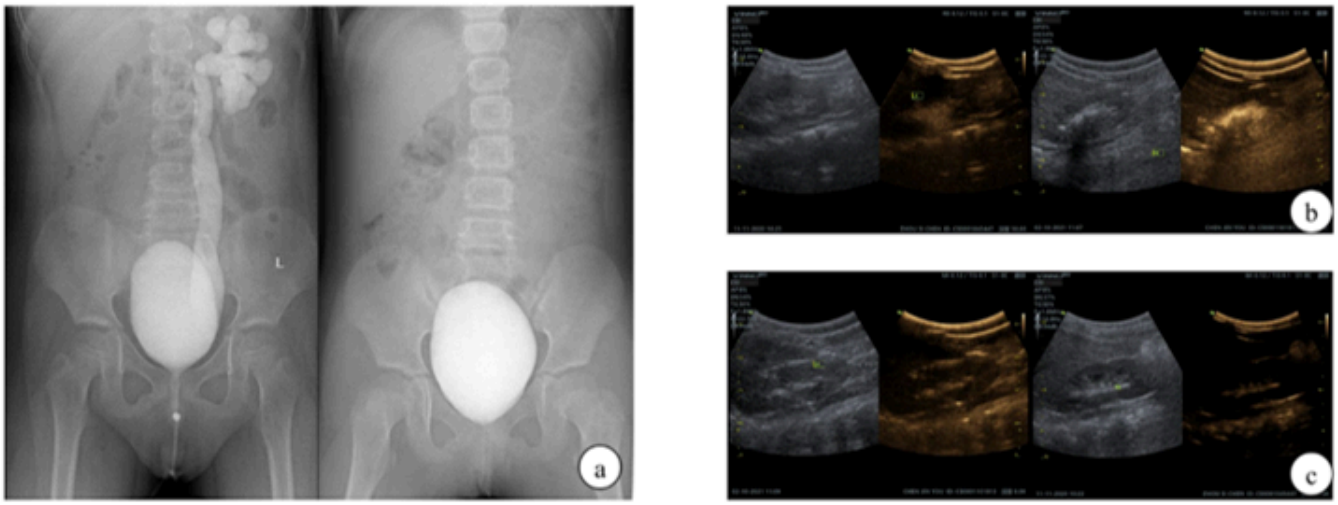

Figure 2

Postoperative follow-up findings. **a** Preoperative imaging demonstrates left-sided grade IV-V VUR; no evidence of reflux is observed on the 6-month postoperative follow-up study. **b** Preoperative contrast-enhanced ultrasonography reveals bilateral grade IV VUR. **c** Follow-up contrast-enhanced ultrasonography at 6 months postoperatively shows no significant reflux

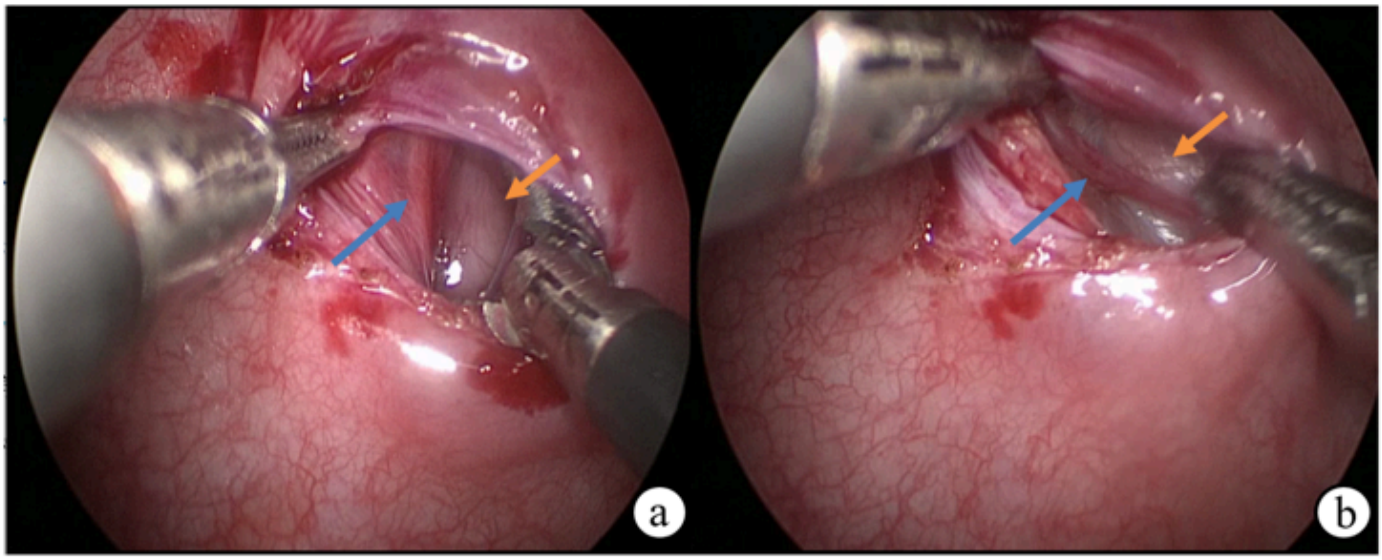

Figure 3

Intraoperative pneumovesicoscopic views during a right-sided Politano-Leadbetter ureteral reimplantation, illustrating the critical anatomical relationship between the vas deferens and ureter. **a** View from the new hiatus, with the vas deferens (blue arrow) positioned medial to the ureter (yellow arrow). **b**The convergence point of the vas deferens and ureter is clearly visualized.