



Endoscopic Puncture Versus Classic Incision for Pediatric Ureterocele: Comparative Outcomes

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Abstract

Objectives This study aims to evaluate and compare the outcomes of two commonly used endoscopic surgical techniques—puncture and classic incision—for the treatment of pediatric intravesical ureterocele in patients with duplicated collecting systems.

Methods We conducted a prospective study involving 34 children with unilateral intravesical ureterocele associated with a duplex renal system, treated between April 2023 and October 2024 at two major university hospitals. Patients were randomized into two groups. Group A (n=17) underwent endoscopic puncture decompression, while Group B (n=17) received a classic transverse incision using an electrocautery knife. Data collected included demographics, presenting symptoms, preoperative imaging, postoperative vesicoureteral reflux (VUR), and the need for secondary interventions.

Results The puncture group exhibited a postoperative de novo VUR rate of 5.9%, whereas the incision group showed a rate of 23.5%. Reintervention was required in 0% and 11.8% of cases in Groups A and B, respectively. Both groups had full symptomatic resolution, but the puncture group demonstrated more consistent improvement on ultrasonography. Though statistical significance was not reached, the clinical trends favored the puncture technique.

Conclusions Endoscopic puncture appears to be a safe and effective alternative to classic incision for decompression of pediatric ureteroceles. It is associated with fewer postoperative complications and may preserve the natural anti-reflux mechanism better. These findings support considering puncture as a first-line treatment in selected pediatric cases.

Keywords Ureterocele, pediatric urology, vesicoureteral reflux, endoscopy, puncture

Introduction

Ureterocele is a congenital anomaly characterized by cystic dilation of the distal ureter as it enters the bladder. This condition, which occurs due to a defect in the Chwalla membrane, results in a ballooning sac that can obstruct urinary outflow and cause a range of clinical symptoms. Ureteroceles are relatively uncommon, with reported incidences ranging from 1 in 500 to 1 in 4,000 live births and are more prevalent in females and in individuals with duplicated collecting systems [1]. In such systems, the ureter from the upper renal moiety typically terminates abnormally, often contributing to ureterocele formation.

Clinically, ureteroceles can present with a spectrum of signs, depending on the degree of obstruction and associated anomalies. Recurrent urinary tract infections (UTIs), antenatally detected hydronephrosis, incontinence, or urinary retention are common modes of presentation [2,3]. If untreated, persistent obstruction may lead to progressive upper tract damage, scarring, and eventual loss of renal function. Therefore, timely diagnosis and intervention are crucial to preserving renal function and ensuring symptom resolution.

Diagnostic imaging plays a pivotal role in the evaluation of ureteroceles. Ultrasound typically reveals a cystic intravesical mass with upstream hydronephrosis. A voiding cystourethrogram (VCUG) is critical for assessing associated vesicoureteral reflux (VUR), while advanced modalities like magnetic resonance urography or renal scintigraphy may be required for detailed anatomical delineation and functional assessment [3]. Once diagnosed, the therapeutic approach is influenced by the patient's age, renal anatomy, and clinical symptoms, as well as the type and location of the ureterocele.

Traditionally, treatment strategies for ureteroceles ranged from open surgical reimplantation and heminephrectomy to less invasive options. In contemporary pediatric urology, endoscopic techniques have emerged as the preferred initial approach, especially for intravesical ureteroceles. These methods are less invasive, provide quicker recovery, and carry reduced morbidity compared to open procedures [4,5]. However, the debate

continues regarding the optimal endoscopic technique—puncture versus incision.

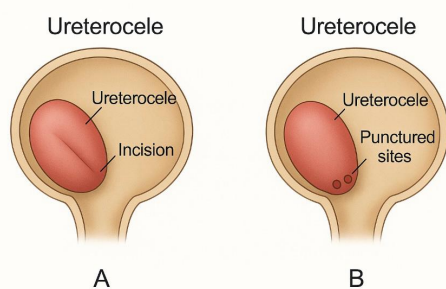
The classic incision technique involves creating a transverse or longitudinal slit through the ureterocele using electrocautery or a cold knife. This method is widely practiced due to its simplicity and immediate decompression results. Nonetheless, it may disrupt the natural anti-reflux mechanism of the ureterovesical junction, leading to a higher incidence of postoperative VUR [5,6].

Alternatively, the puncture technique, which uses multiple small fenestrations at the dependent portion of the ureterocele, aims to achieve decompression while preserving ureteral function. This technique minimizes trauma to the bladder mucosa and theoretically reduces the risk of inducing reflux. Several studies have suggested favorable outcomes with this approach, including lower rates of de novo VUR and fewer secondary interventions [7–9].

Despite widespread clinical use of both methods, there is a paucity of robust comparative data in the pediatric population. Particularly lacking are prospective randomized trials evaluating outcomes in children with intravesical ureteroceles associated with duplicated collecting systems—a subset of patients that constitutes a significant proportion of cases. Understanding which technique yields better clinical outcomes in this group can guide treatment selection and optimize long-term renal preservation.

This study aims to address this gap by conducting a prospective randomized comparison of endoscopic puncture versus classic incision in the treatment of intravesical ureteroceles among pediatric patients with duplicated systems. We focus on important clinical endpoints including the incidence of postoperative de novo VUR, need for secondary surgical intervention, radiologic improvement, and symptomatic resolution. Our hypothesis is that puncture may offer a safer and equally effective alternative with fewer complications, particularly in appropriately selected cases.

Figure 1: Schematic Diagram of Puncture and Classic Incision Techniques



This figure illustrates the endoscopic approach to puncture and classic incision techniques for decompressing intravesical ureterocele. The puncture technique involves one or more small fenestrations at the most dependent part of the ureterocele, while the incision approach creates a transverse or longitudinal slit using electrocautery or a cold knife.

Methods:

This prospective randomized clinical trial was conducted over an 18-month period, from April 2023 to October 2024, at the pediatric urology units of two major tertiary care centers: Cairo University Children's Hospital and Fayoum University Hospital. Institutional Review Board (IRB) approval was obtained prior to study initiation (FU- R451), and informed consent was obtained from the legal guardians of all enrolled patients.

Study Population: Eligible participants were pediatric patients aged between 3 months and 6 years, presenting with a diagnosis of unilateral intravesical ureterocele in the setting of a duplex renal collecting system.

The diagnosis was confirmed through a combination of imaging modalities including renal ultrasonography, voiding cystourethrogram (VCUG), and in selected cases, magnetic resonance urography (MRU) or 99mTc-DMSA renal scintigraphy to assess differential renal function and parenchymal scarring. Inclusion criteria required radiologically confirmed duplex systems with a functioning upper moiety with a single ureterocele involving the upper pole moiety and absence of prior surgical intervention.

According to the incidence of de novo VUR, the primary endpoint of the study, (8.7% post puncture v.s 58.5% post incision as reported by Pogorelec et

al, the sample size was calculated using MedCalc statistical software calculator and 14 patients per group was needed to formulate a study with a power of 90%, and 10% attrition rate.

Exclusion criteria included patients with bilateral ureteroceles, ectopic ureteroceles (extending below the bladder neck). Non-functioning upper moiety in complete duplex system as it needs an upper tract approach intervention rather than drainage by incision. Also, in exclusion criteria patients with single system ureteroceles, solitary kidney, or any associated urological anomalies such as posterior urethral valves or bladder exstrophy. Patients with significant comorbidities or those unfit for anesthesia were also excluded.

Randomization and Group Allocation: A total of 34 patients meeting the eligibility criteria were enrolled in the study and randomly assigned into two equal groups (n=17 per group) using the sealed opaque envelope method. The randomization was performed by an independent investigator not involved in the surgical procedures or postoperative assessments to ensure allocation concealment. Group A (Puncture Group): Underwent endoscopic puncture decompression of the ureterocele. Group B (Incision Group): Underwent classic transverse incision of the ureterocele using an electrocautery knife.

Surgical Technique: All procedures were performed under general anesthesia by experienced pediatric urologists with standard cystoscopic equipment.

For Group A, puncture decompression was performed using a 3Fr Bugbee electrode or cystoscopic needle through a 9.5 Fr cystoscope. Multiple punctures (typically 3–5) were made at the most dependent portion of the ureterocele dome to facilitate gravity-assisted drainage. Care was taken to avoid excessive mucosal injury to preserve the natural anti-reflux mechanism.

In Group B, a classic transverse incision was made using either a cold knife or a monopolar electrocautery hook. The incision was positioned at the dome of the ureterocele, creating a 3–5 mm slit sufficient to collapse the sac and relieve obstruction. Hemostasis was ensured, and the bladder was irrigated at the end of the procedure.

All patients were catheterized postoperatively with an 8 Fr Foley catheter for 24–48 hours and

discharged once voiding was established and clinical recovery was satisfactory.

Postoperative Follow-up: Follow-up evaluations were scheduled at 1, 3, and 6 months postoperatively. Each follow-up visit included a structured clinical assessment for symptom resolution (e.g., fever, dysuria, incontinence), urine analysis, and renal ultrasonography to evaluate changes in hydronephrosis and residual ureterocele cavities.

A repeat VCUG was performed at the 3-month follow-up to assess the development of de novo vesicoureteral reflux (VUR) or progression of pre-existing reflux. In patients with persistent hydronephrosis, unresolved symptoms, or abnormal renal function tests, further evaluation with DMSA scan or MRU was undertaken to guide management.

During follow up, kidney ultrasonography and VCUG were the main imaging- based follow up and the renal function was assessed by renography only in cases of increasing hydronephrosis or symptoms. However, it would be better to make the renography-mediated renal function as a routine method for follow up.

Outcome Measures: The primary outcome was the incidence of postoperative de novo VUR detected on VCUG. Secondary outcomes included: symptom resolution at 6 months, Radiologic improvement in hydronephrosis or ureterocele size, need for secondary surgical intervention (e.g., ureteral reimplantation or upper pole heminephrectomy) and changes in urine analysis (e.g., resolution of pyuria or hematuria).

Statistical Analysis

Data was compiled and analyzed using SPSS software version 25. Categorical variables were expressed as frequencies and percentages, and comparisons between groups were made using the chi-square or Fisher's exact test where appropriate. Continuous variables were presented as mean \pm standard deviation and analyzed using the student's t-test. A p-value of <0.05 was considered statistically significant.

Subgroup analyses were conducted to assess outcomes based on age, sex, and initial presentation (UTI, hydronephrosis, incontinence). Kaplan-Meier curves were constructed to visualize time to symptom resolution and time to secondary

intervention, though survival analysis was not the primary focus of this study.

Results

A total of 34 pediatric patients were included in the study, evenly randomized into two treatment groups. The baseline characteristics of the groups were comparable, ensuring balance in age, sex, and presenting symptoms.

Patient Demographics and Baseline Characteristics:

The mean age of participants was 24.3 ± 6.7 months, with no significant age difference between Group A (puncture group: 24.1 ± 6.5 months) and Group B (incision group: 24.5 ± 6.9 months) ($p = 0.87$).

The male-to-female ratio was nearly equal in both groups: 9:8 in the puncture group and 8:9 in the incision group.

The most common presenting complaint was recurrent urinary tract infections (UTIs), noted in 14 patients (41%). Five patients (29%) in each group had been diagnosed antenatally with hydronephrosis, while urinary incontinence was reported in six children (18%). All patients had confirmed duplex systems on imaging, and the ureterocele was intravesical in every case. Preoperative VCUG identified associated VUR in 38% of cases, predominantly affecting the upper pole moiety.

Operative Details and Immediate Postoperative

Recovery: All procedures were completed successfully without intraoperative complications. The average operative time was shorter in the puncture group (mean: 17.2 ± 2.3 minutes) compared to the incision group (mean: 22.4 ± 3.1 minutes), although this difference was not statistically significant ($p = 0.08$). Postoperative bladder catheterization lasted an average of 1.2 days in Group A versus 1.6 days in Group B.

No cases required conversion to open surgery, and all patients were discharged within 48 hours of surgery. No immediate postoperative complications such as fever, hematuria, or urinary retention were documented.

Primary Outcome: Development of De Novo VUR:

The incidence of de novo vesicoureteral reflux (VUR) was significantly lower in the puncture group.

Only 1 out of 17 patients in Group A (5.9%) developed new-onset VUR on follow-up VCUG, compared to 4 patients (23.5%) in the incision group ($p = 0.206$). Although this did not reach statistical significance, the trend suggested a potential advantage for the puncture technique in preserving the ureterovesical junction integrity.

The single case of de novo VUR in the puncture group was of low grade (Grade II) and resolved spontaneously on subsequent imaging. In contrast, the VUR cases in Group B included one Grade III and one Grade IV reflux, both of which persisted and contributed to further interventions.

Secondary Outcomes: Reintervention Rates; No patients in the puncture group required additional procedures during the 6-month follow-up. In contrast, two patients (11.8%) in the incision group required secondary intervention: one underwent ureteral reimplantation for persistent obstruction and another required a heminephrectomy due to progressive renal deterioration ($p = 0.429$).

Symptom Resolution:All 34 patients achieved full symptomatic resolution by the 3-month visit, including relief from recurrent UTIs and incontinence. There was no statistical difference between groups in this outcome ($p = 1.000$), indicating that both procedures were effective in alleviating presenting symptoms.

Radiologic Outcomes:Ultrasound at 6 months showed improvement or resolution of hydronephrosis in 94.1% of patients in the puncture group compared to 88.2% in the incision group ($p = 0.643$). Complete decompression of the ureterocele cavity was observed in 15 patients in Group A and 14 patients in Group B.

Urine Analysis Improvement:Resolution of abnormal urine findings (e.g., pyuria, hematuria) was seen in 88.2% of the puncture group versus 76.5% of the incision group ($p = 0.390$). This aligns with clinical improvement and radiologic decompression.

These results suggest a favorable profile for the puncture technique, particularly with respect to minimizing de novo reflux and avoiding additional surgical interventions, while maintaining equivalent efficacy in symptom resolution.

Table 1: Patient Demographics and Clinical Presentation

Parameter	Puncture Group (n=17)	Incision Group (n=17)
Mean Age (months)	24.1 ± 6.5	24.5 ± 6.9
Male: Female Ratio	9:8	8:9
Antenatal Diagnosis	5 (29%)	5 (29%)
UTI Presentation	7 (41%)	7 (41%)
Incontinence	3 (18%)	3 (18%)
GFR (ipsilateral) ml/min	45.7±24.9	43.8±19.4

Table 2: Comparative Outcomes Between Puncture and Classic Incision Groups

Parameter	Puncture group (n=17)	Incision group (n=17)	P-value
De novo VUR	1 (5.9%)	4 (23.5%)	0.206
Reintervention	0 (0%)	2 (11.8%)	0.429
Symptom resolution	17 (100%)	17 (100%)	1.000
Hydronephrosis improvement	16 (94.1%)	15 (88.2%)	0.643
Urine analysis improvement	15 (88.2%)	13 (76.5%)	0.390

Discussion

This prospective randomized study provides valuable insights into the comparative efficacy and safety of endoscopic puncture versus classic incision techniques in the management of pediatric intravesical ureteroceles in patients with duplicated systems. While both approaches were clinically effective in resolving symptoms and decompressing the ureterocele, our findings indicate that the puncture technique may offer distinct advantages, particularly in terms of postoperative complication rates and the need for reintervention.

Following ureterocele incision or puncture, a newly developed vesicoureteral reflux (VUR) may arise. Management options for this disease include watchful waiting,an upper-to-lower uretero-ureterostomy, or ureterovesical reimplantation, Giulianelli R, et al. Our data showed a notably lower incidence of de novo vesicoureteral reflux (VUR) in

the puncture group (5.9%) compared to the incision group (23.5%). Although this difference did not reach statistical significance, the observed trend supports existing literature suggesting that puncture decompression is less disruptive to the natural anti-reflux mechanism at the ureterovesical junction. The anatomical integrity of this junction is crucial, especially in the pediatric population, as postoperative reflux can predispose patients to recurrent UTIs, renal scarring, and long-term renal impairment [1,2].

Several previous studies have emphasized this concern. In a large retrospective series by Arena *et al.*, the rate of postoperative reflux following electrosurgical incision was reported to be as high as 30%, whereas puncture techniques showed lower complication rates over long-term follow-up [6]. Similarly, Koyle *et al.* noted that puncture was associated with favorable outcomes, provided the ureterocele was intravesical and the renal function was preserved [4].

The higher VUR rate in the incision group of our cohort also correlated with the need for secondary surgical interventions, including ureteral reimplantation and heminephrectomy. In contrast, the puncture group had zero reinterventions, reinforcing the notion that a less invasive, mucosa-sparing approach can effectively relieve obstruction while minimizing morbidity.

An important strength of our study is its prospective randomized design, which reduces selection bias and allows for a more balanced comparison. Additionally, our inclusion criteria—limited to intravesical ureteroceles in patients under 6 years with duplicated systems—helped ensure a homogenous population and enhance the generalizability of findings to a commonly encountered clinical scenario.

From a surgical standpoint, the puncture technique offers several practical benefits. It is technically simpler and quicker, which we observed in the shorter operative time (although not statistically significant). The avoidance of deep mucosal incisions may also contribute to faster recovery, reduced catheterization duration, and potentially decreased bladder irritation. While not directly assessed in our study, these advantages may

translate into better patient comfort and reduced healthcare costs.

That said, the classic incision approach retains its value in certain clinical situations. For instance, patients with large ureteroceles or thick-walled sacs may benefit from a more definitive incision to ensure complete decompression. Additionally, when coexisting anomalies such as high-grade VUR or severely impaired renal segments are present, incision may allow for better intraoperative visualization and tailored management. Churchill *et al.* have previously emphasized that incision remains the preferred option in more complex or recurrent cases [2].

In our study, both techniques achieved a 100% rate of symptom resolution, underscoring the effectiveness of endoscopic decompression as a first-line treatment for intravesical ureteroceles. This aligns with prior literature which supports the role of minimally invasive approaches in managing ureteroceles with favorable anatomy and function [5,9]. Our finding of improved hydronephrosis and favorable urine analysis outcomes in both groups further corroborates their efficacy.

The use of postoperative VCUG and ultrasound at standardized follow-up intervals allowed us to capture both functional and anatomical outcomes. Notably, the high rate of hydronephrosis resolution in the puncture group (94.1%) is consistent with effective drainage and supports its continued use in clinical practice. Moreover, the observed improvement in urine analysis in 88.2% of puncture patients may reflect reduced inflammation and infection risk following minimally traumatic intervention.

Several recent systematic reviews echo our findings. A 2022 meta-analysis by Anand *et al.* concluded that endoscopic puncture—particularly laser puncture—is associated with significantly lower rates of reflux and reoperation compared to electrocautery incision [11]. Likewise, Wahyudi *et al.* (2023) demonstrated that puncture techniques had better safety profiles and comparable efficacy in decompression across multiple studies involving over 400 pediatric cases [12].

Conclusions

In conclusion, our study demonstrates that endoscopic puncture is a safe, effective, and potentially superior alternative to classic incision in the management of pediatric intravesical ureteroceles in duplicated systems. The lower incidence of postoperative VUR, zero reintervention rate, and high symptomatic success highlight its value as a first-line treatment. While individualized treatment decisions remain essential, especially in complex cases, puncture should be strongly considered in anatomically suitable candidates. Further studies are warranted to confirm long-term outcomes and to integrate this approach more broadly into standardized pediatric urologic practice.

Limitations

Despite these promising findings, our study is not without limitations. The relatively small sample size may have limited the statistical power to detect significant differences in some outcomes, particularly VUR and reintervention. Additionally, while our follow-up duration of 6 months is adequate to assess early outcomes, long-term surveillance is necessary to evaluate recurrence rates, renal growth, and the durability of decompression.

Future research should focus on multicenter randomized trials with longer follow-up periods to validate our findings and further refine patient selection criteria. Comparative analyses involving newer energy sources (e.g., Holmium:YAG or Thulium fiber laser) and alternative techniques such as balloon dilation may also yield insights into optimizing minimally invasive treatment for ureteroceles.

Declarations:

Ethical approval and consent to participate: Institutional Review Board (IRB) approval was obtained prior to study initiation (FU- R451), and informed consent was obtained from the legal guardians of all enrolled patients.

Availability of data and materials: This prospective randomized clinical trial was conducted over an 18-month period, from April 2023 to October 2024, at the pediatric urology units of two major tertiary care centers: Cairo University Children's Hospital and Fayoum University Hospital

Conflict of interest: The authors declare no conflict of interest in connection with reported study

Funding: The authors declare that there was no extramural funding of the study, study depended on self-funding.

Authors contribution: Hisham Ibrahim, Waseem Abou-ela and Mahmoud Shoukry contributed to the study of conception and design. Material preparation, Project administration, data collection and analysis were performed by Hisham Ibrahim, Hossam shaker, and sameh kotb. The first draft of the manuscript was written by Hisham Ibrahim. All authors read and approved of the final manuscript. All authors shared in the study and drafting. All authors approved the final manuscript.

List of abbreviations: Vesicoureteral reflux (VUR), voiding cystourethrogram (VCUG).

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