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Original Research

Distal ureteroureterostomy in children with duplex kidney anomalies: Safety and preservation of the recipient lower moiety

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Summary

Objective
Distal ureteroureterostomy (UU) has become an increasingly accepted renal-preserving reconstructive option for children with duplex kidney anomalies and ectopic or obstructed upper moiety ureters. However, concerns persist that UU may compromise the healthy recipient lower moiety. The aim of this study was to evaluate the outcomes after distal UU in children with duplex kidney anomalies.

Methods
A retrospective review was performed of all children who underwent distal UU for duplex kidney anomalies at our institution between 2008 and 2025.

Results
Fifty-three children underwent distal UU with a median age at surgery of 15 months. Median operative time was 118 min. No intraoperative complications occurred. Early postoperative febrile urinary tract infections developed in 3/53 patients (5.7%). Forty-five children had available follow-up, with a median duration of 45 months. In patients with preoperative upper moiety hydronephrosis, significant postoperative improvement was observed ($p < 0.001$). No patient developed clinically relevant obstruction of the recipient lower moiety or required reoperation. Mild asymptomatic lower moiety hydronephrosis developed in only two children, both demonstrating unobstructed drainage on postoperative scintigraphy. Initial donor ureter diameter was not associated with adverse postoperative outcomes.

Conclusion
Distal UU is a safe, effective, and definitive reconstructive option for duplex kidney anomalies. After a median follow-up of 45 months, no clinically relevant recipient lower moiety obstruction was observed and no reoperation was required.

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Introduction

Duplex kidney anomalies are among the most common congenital malformations encountered in pediatric urology and, according to the Weigert—Meyer rule, the upper moiety is most commonly affected by obstructive pathology or extravesical ectopy [1]. Over recent decades, surgical management has progressively shifted from ablative procedures, such as upper pole heminephrectomy with or without ureterectomy, toward renal-preserving reconstructive approaches [2,3]. This change has been driven by increasing recognition that heminephrectomy, although effective in the treatment of a non- or poorly functioning upper moiety, may be associated with morbidity affecting the remaining ipsilateral moiety, including perioperative urinoma formation, recurrent infections, vascular compromise and deterioration or loss of lower moiety function [4]. Distal ureteroureterostomy (UU) represents an effective renal-preserving reconstructive alternative by draining the affected upper moiety ureter into the ipsilateral lower moiety ureter while avoiding hilar dissection and preserving renal architecture.

Despite the growing acceptance of UU, concerns have traditionally persisted regarding the safety of the recipient lower moiety. Potential risks include obstruction of the recipient ureter, anastomotic complications, worsening hydronephrosis, recurrent infections, yo—yo reflux, and eventual deterioration of lower moiety function. Since 2008, our center has adopted distal UU for the routine management of duplex kidney anomalies in children with an obstructed or ectopic upper moiety ureter and a non-refluxing recipient lower moiety ureter. The aim of the present study was to evaluate the outcomes after distal UU in children with duplex kidney anomalies, with particular focus on perioperative and postoperative complications and preservation of the recipient lower moiety.

Materials and methods

A retrospective review of all patients younger than 18 years who underwent UU at our center for the treatment of duplex kidney anomalies between 2008 and 2025 was undertaken. Follow-up was defined as the interval between the UU procedure and the last outpatient follow-up visit.

In our center, all patients with duplex kidney anomalies underwent standardized preoperative ultrasound examination of the kidneys and lower urinary tract. In patients with hydronephrosis, the anteroposterior (AP) diameter of the affected renal pelvis was consistently measured and documented at the level of the pyeloureteral junction and dilated ureters were consistently measured distally in the retrovesical region. Indications for UU onto the lower moiety ureter included ectopic or obstructed upper pole ureters associated with progressive upper tract dilatation, recurrent febrile UTIs, or urinary incontinence in older children. Diagnostic evaluation also included a single-cycle voiding cystourethrography (VCUG) to assess for vesicoureteral reflux (VUR) and associated lower urinary tract abnormalities. A prerequisite for performing UU was the absence of vesicoureteral reflux in the recipient lower moiety tract and the presence of a non-obstructed lower moiety ureter. In cases with VUR affecting the lower moiety ureter, antireflux common sheath ureteral reimplantation of both ureters into the bladder was preferred; these patients were therefore not included in the present study. The caliber of the upper moiety ureter itself was not considered a limiting factor in the decision-making process for performing UU.

All procedures were performed under general anesthesia. Initially, urethrocystoscopy was routinely undertaken to evaluate the orthotopic lower moiety ureteral orifice and to exclude the presence of ureterocele. Subsequently, a ureteral stent was placed into the lower moiety ureter to facilitate intraoperative identification, and the endoscopic procedure was terminated. The patient was then positioned in a slightly extended supine position. A transverse inguinal incision of approximately 4—5 cm was performed along the inguinal skin crease, similar to an inguinal hernia incision [5—7]. After incision of the external oblique fascia, a muscle-splitting approach was used to gain access to the retroperitoneal space without entering the peritoneal cavity. The duplicated ureters were identified in the retroperitoneum between the obliterated umbilical artery and the iliac vessels. Careful dissection of both ureters was performed while preserving the vascular supply of the recipient lower moiety ureter. The dilated upper moiety ureter was transected distally. Subsequently, an end-to-side distal UU between the upper moiety ureter and the lower moiety ureter was performed using fine absorbable running sutures in a tension-free and watertight fashion [5—7]. The residual upper moiety ureteral stump was routinely closed using absorbable suture material. The lower moiety ureteral stent was left in situ and removed several weeks postoperatively. In patients receiving continuous antibiotic prophylaxis preoperatively, prophylaxis was discontinued following successful distal ureteroureterostomy.

Follow-up was routinely performed in the outpatient clinic of our institution. During each follow-up visit, ultrasound examination of the kidneys and lower urinary tract was performed in a standardized fashion comparable to the preoperative ultrasound evaluation. In addition, a detailed medical history was obtained at every visit, with particular emphasis on the occurrence of febrile UTIs.

Statistical analysis was performed using the Mann—Whitney U test to compare continuous variables between independent groups, and the Wilcoxon signed-rank test to compare paired pre- and postoperative measurements. A p value < 0.05 was considered statistically significant.

Results

Between 2008 and 2025, 53 children underwent distal UU for duplex kidney anomalies [Fig. 1]. The cohort included 45 girls and 8 boys, with a median age at surgery of 15 months. The left kidney was affected in 29/53 patients (54.7%). The main indications for surgery were recurrent febrile UTIs despite continuous antibiotic prophylaxis (CAP) (25/53, 47.2%), progressive upper tract dilatation (18/53, 34.0%), and urinary incontinence due to ectopic upper

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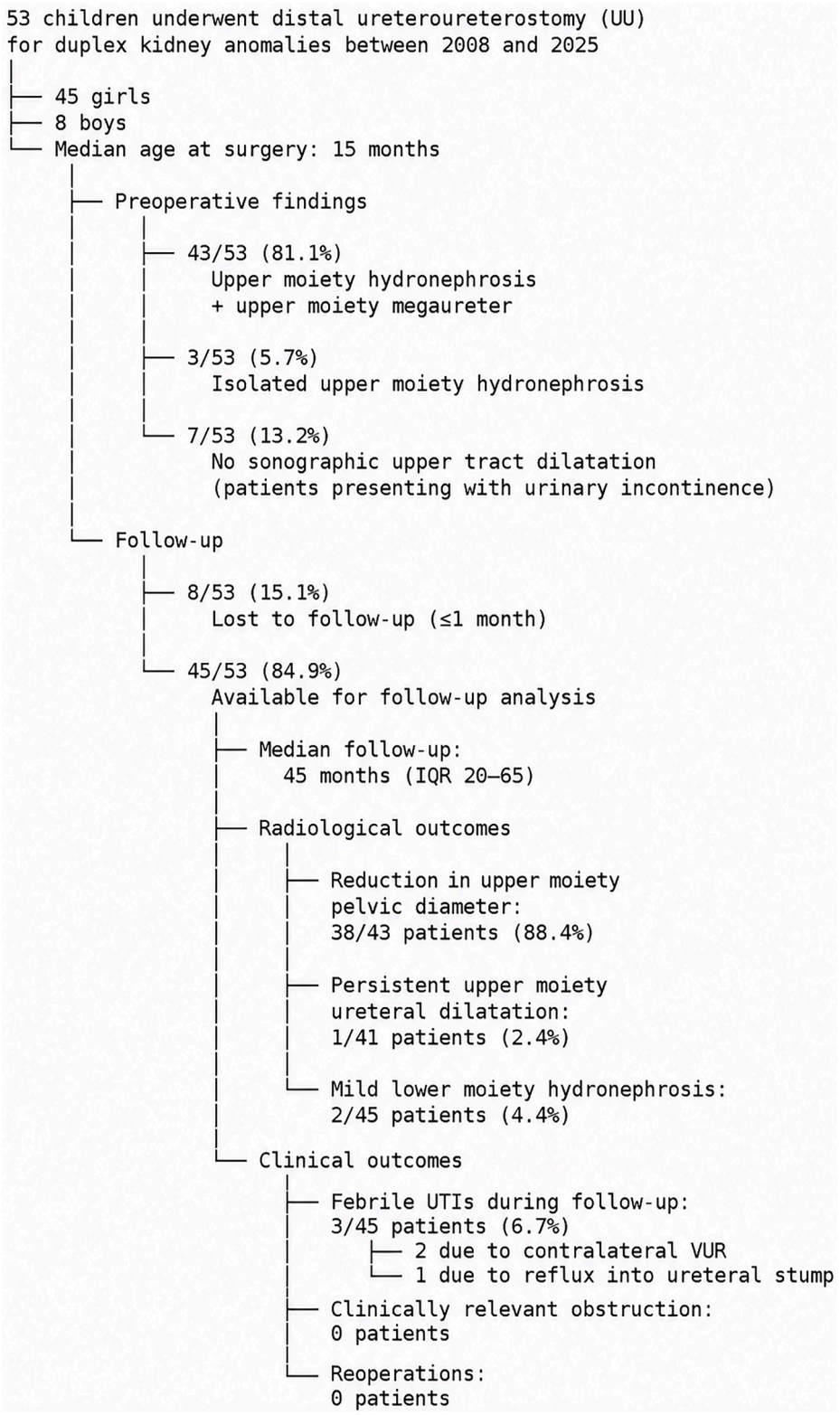


Fig. 1 Flowchart of the study cohort demonstrating preoperative sonographic findings and postoperative radiological and clinical outcomes after distal ureteroureterostomy for duplex kidney anomalies.

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Table 1 Baseline characteristics of the 53 children undergoing distal ureteroureterostomy for duplex kidney anomalies in our center. AP = anteroposterior; UTI = urinary tract infection.

Number of patients	53
Female sex, n (%)	45 (84.9%)
Male sex, n (%)	8 (15.1%)
Affected renal unit, n (%)	
• Left	29 (54.7%)
• Right	24 (45.3%)
Median age at surgery, months (IQR)	15 (6—29)
Position of upper moiety ureteral orifice in girls, n (%)	
• Bladder neck	23 (51.1%)
• Vagina	8 (17.8%)
• Vestibulum vaginae	8 (17.8%)
• Unknown/not cystoscopically identified	6 (13.3%)
Position of upper moiety ureteral orifice in boys, n (%)	
• Bladder neck	5 (62.5%)
• Prostatic urethra	3 (37.5%)
Indications for UU, n (%)	
• Patients with febrile UTIs prior to surgery	25 (47.2%)
• Patients with progressive upper tract dilatation	18 (34.0%)
• Patients presenting with urinary incontinence (all female)	10 (18.9%)
Patients with a dilated distal upper moiety ureter, n (%)	43 (81.1%)
• Median distal upper moiety ureter diameter, mm (IQR)	12 (9—16)
Patients with a dilated upper moiety pelvis, n (%)	46 (86.8%)
• Median AP diameter of the upper moiety pelvis, mm (IQR)	18 (11—20)

moiety ureteral insertion (10/53, 18.9%; all girls) [Table 1]. Of the 25 children with recurrent febrile UTIs despite CAP, 23 were girls and 2 were boys. Of the two boys, one was circumcised and one was uncircumcised. Two of the 53 children (3.8%), both girls, had previously undergone endoscopic decompression of an upper moiety ureterocele before distal ureteroureterostomy. In all cases, the upper moiety ureter was anastomosed to the lower moiety ureter.

Perioperative findings and complications

Preoperatively, combined upper moiety hydronephrosis and megaureter were present in 43/53 patients (81.1%), isolated upper moiety hydronephrosis in 3/53 (5.7%), while 7/53 incontinent girls (13.2%) had no sonographic upper tract dilatation. Median distal upper moiety ureteral diameter was 12 mm (IQR 9—16), and median upper moiety pelvic diameter was 18 mm (IQR 11—20). Preoperative single-cycle VCUG demonstrated reflux into the upper moiety ureter in 7 of 53 patients (13.2%).

Table 2 Perioperative, radiological and clinical outcomes following distal ureteroureterostomy in children with duplex kidney anomalies. Radiological outcomes were assessed by serial ultrasound examinations during follow-up. UTI = urinary tract infection.

Median operative time, minutes (IQR)	118 (102—141)
Intraoperative complications, n (%)	0 (0%)
Early postoperative complications, n (%)	3/53 (5.7%)
• Febrile UTIs, n (%)	3/53 (5.7%)
Median follow-up, months (IQR)	45 (20—65)
Improvement of upper moiety hydronephrosis, n (%)	38/43 (88.4%)
Persistence of upper moiety ureteral dilatation, n (%)	1/41 (2.4%)
Residual upper moiety hydronephrosis at last follow-up, n (%)	24/43 (55.8%)
Mild lower moiety hydronephrosis, n (%)	2/45 (4.4%)
Clinically relevant lower moiety obstruction, n (%)	0 (0%)
Patients with febrile UTIs during follow-up, n (%)	3/45 (6.7%)

The location of the ectopic upper moiety ureteral insertion was determined by intraoperative cystoscopy. In girls, the upper moiety ureter inserted most commonly at the bladder neck (51.1%), followed by the vagina or vestibulum vaginae (each 17.8%). In 6 girls (13.3%), the upper moiety ureteral orifice could not be identified. In boys, insertion was identified at the bladder neck (62.5%) or prostatic urethra (37.5%).

Median operative time was 118 min (IQR 102—141). No intraoperative complications occurred. Early postoperative (<6 weeks) febrile UTIs developed in 3/53 patients (5.7%) (two girls and one uncircumcised boy), and no postoperative Clavien—Dindo grade III or higher complications were observed [Table 2].

Follow-up

Eight patients (15.1%), all girls, were lost to follow-up within 1 month after surgery. The remaining 45 children had a median follow-up of 45 months (IQR 20—65). Among these patients, 43 (95.6%) demonstrated preoperative upper moiety hydronephrosis, including 41 (91.1%) with combined upper moiety ureteral and pelvic dilatation and 2 (4.4%) with isolated upper moiety pelvic dilatation without associated ureteral dilatation. The remaining 2 patients (4.4%), both girls, showed no preoperative sonographic upper tract dilatation.

Upper moiety ureteral dilatation resolved or improved in nearly all patients [Fig. 2]; persistence was observed in only 1/41 children (2.4%) with preoperative megaureter. Significant improvement in upper moiety hydronephrosis was observed in 38/43 patients (88.4%) with an initial hydronephrosis of the upper moiety, with a median reduction in pelvic diameter of 11 mm (IQR 7—16; $p < 0.001$). Residual hydronephrosis persisted in 24/43 patients (55.8%) but was generally mild and asymptomatic (median 10 mm). Four patients demonstrated asymptomatic sonographic enlargement of the upper moiety (median enlargement 5 mm). Larger preoperative pelvic diameter was associated with

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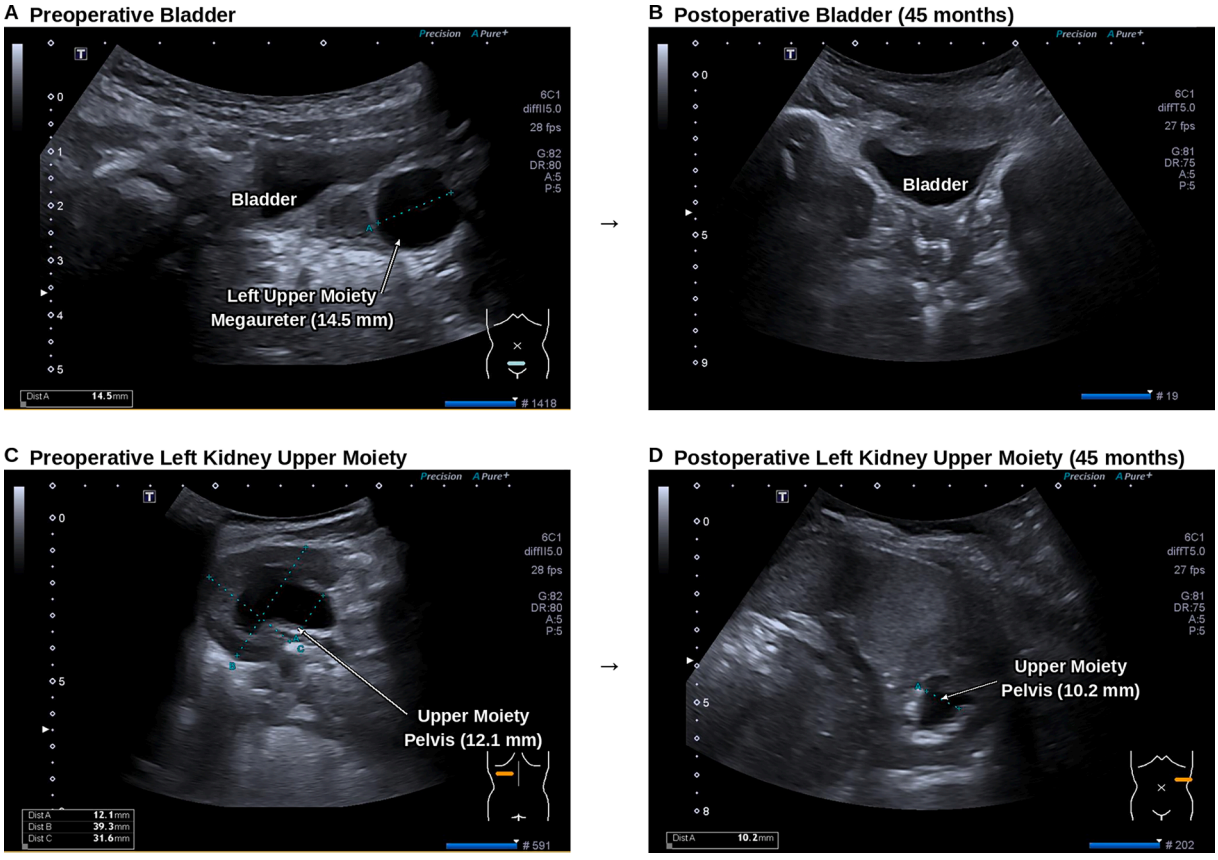


Fig. 2 Preoperative and postoperative ultrasound findings in a 13-month-old girl with an obstructive non-refluxing left upper moiety megaureter associated with recurrent febrile urinary tract infections. Preoperative ultrasound demonstrated a retrovesically dilated upper moiety ureter (A) and marked upper moiety hydronephrosis (C). Intraoperative cystoscopy identified an ectopic insertion of the upper moiety ureter at the level of the bladder neck, and distal ureteroureterostomy onto the lower moiety ureter was performed. No perioperative or postoperative complications occurred. Follow-up ultrasound 45 months after surgery demonstrated complete regression of the ureteral dilatation (B) and improvement of the upper moiety hydronephrosis (D).
A and **B**: transverse bladder ultrasound images obtained preoperatively at 13 months of age (A) and at last follow-up, 45 months after surgery, at 58 months of age (B).
C and **D**: transverse ultrasound images of the left upper moiety renal pelvis obtained preoperatively in prone position (posterior-anterior orientation) at 13 months of age (C) and at last follow-up in supine position (anterior-posterior orientation) at 58 months of age (D).

persistence of postoperative dilatation ($p = 0.028$), whereas initial ureteral diameter was not significantly associated with persistence of upper moiety dilatation ($p = 0.245$) or with increased upper moiety hydronephrosis ($p = 0.180$).

Two patients (4.4%) developed lower moiety hydronephrosis following the procedure. Initial distal upper moiety ureteral diameter and initial upper moiety pelvic diameter were not significantly associated with newly developed lower moiety hydronephrosis ($p = 0.060$ and $p = 0.115$, respectively). In both cases, subsequent postoperative renal scintigraphy demonstrated unobstructed urinary drainage. During ongoing follow-up, complete resolution of the lower moiety hydronephrosis was observed in one patient, while the second patient remains under annual ultrasound surveillance. In this child, hydronephrosis has remained stable without sonographic signs of progressive dilatation or renal deterioration and therefore repeat renal scintigraphy has not been indicated to date. No patient in our study developed clinically relevant obstruction or required reoperation.

During follow-up (>6 weeks), febrile UTIs occurred in 3/45 patients (6.7%), all of whom were girls. In two patients, contralateral vesicoureteral reflux was identified, and both developed febrile UTIs 3 months after distal ureteroureterostomy at the ages of 8 and 11 months, respectively. The third patient developed a febrile UTI 9 months after surgery at the age of 20 months. VCUG demonstrated reflux into a 2-cm distal ureteral stump. Although surgical excision of the ureteral stump was recommended, the family declined further surgery. Initial ureteral and pelvic diameters were not significantly associated with postoperative febrile UTIs or development of lower moiety hydronephrosis ($p = 0.264$ and $p = 0.289$, respectively).

Discussion

Over the last decades, renal-preserving reconstructive techniques have gained increasing acceptance in the surgical management of duplex kidney anomalies associated with

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ectopic or obstructed upper moiety ureters, with UU becoming one of the most widely adopted approaches [3]. In the present series, distal UU provided excellent outcomes in children with duplex kidney anomalies, with a very low rate of clinically relevant complications and, importantly, without evidence of significant deterioration of the recipient lower moiety. During a median follow-up of 45 months, no patient developed clinically relevant obstruction of the recipient ureter requiring reoperation, while only two children demonstrated mild asymptomatic lower moiety hydronephrosis with unobstructed drainage on postoperative renal scintigraphy scan. Furthermore, postoperative febrile urinary tract infections were uncommon (n = 3, 6.7%) and, in most affected patients (2 out of 3), could be attributed to factors unrelated to the ureteroureterostomy itself. These findings further support the growing body of evidence suggesting that distal UU is a safe and definitive reconstructive option for duplex kidney anomalies with ectopic or obstructed upper moiety ureters [7–9].

A potential criticism of the present study is that differential upper moiety renal function was not routinely assessed preoperatively. However, several contemporary studies have demonstrated that preservation of a poorly functioning or non-functioning upper moiety does not negatively affect outcomes after UU and that upper pole function itself should not necessarily dictate the surgical approach [9,10]. Kawal et al. specifically reported comparable outcomes irrespective of whether upper pole function was below or above 10% [9]. In our institution, distal UU has therefore progressively replaced ablative surgery for duplex anomalies with ectopic or obstructed upper moiety ureters. Our findings further support this concept, as neither presumed poor upper moiety function nor marked ureteral dilatation adversely affected outcomes after distal UU.

The diameter of the upper moiety ureter has historically been regarded as a potential risk factor for adverse outcomes after UU, mainly because of concerns regarding impaired drainage, kinking, or secondary obstruction of the recipient lower moiety. However, the available literature does not support donor ureter diameter as an independent contraindication to UU. Chacko et al. and McLeod et al. both demonstrated safe and successful reconstruction after UU even in children with severely dilated donor ureters [8,11]. Most notably, Harms et al. directly compared donor ureters $<$1.2 cm and $\geq$1.2 cm and found no significant differences in complications, febrile UTIs, reoperations, operative time, or hospital stay [12]. Abdelhalim et al. likewise identified hydronephrosis affecting both moieties, rather than donor ureter diameter itself, as a predictor of adverse outcomes after UU [13]. Our findings are consistent with these reports. In the present series, the caliber of the upper moiety ureter was not considered a limiting factor for distal UU, and initial distal upper moiety ureteral diameter was not significantly associated with persistence of upper moiety dilatation, increased postoperative upper moiety hydronephrosis, newly developed lower moiety hydronephrosis, or postoperative febrile UTIs. The only factor significantly associated with persistence of upper moiety hydronephrosis after surgery was the preoperative anteroposterior diameter of the upper moiety renal pelvis (p = 0.028), suggesting that the severity of pre-existing upper tract dilatation rather than donor ureter caliber itself may influence postoperative sonographic persistence of upper moiety hydronephrosis. Collectively, our findings further support the concept that even markedly dilated donor ureters should not preclude distal UU.

In our center, distal rather than proximal UU has been the preferred reconstructive approach. We believe that distal UU through a small inguinal incision offers several important advantages. The distal ureters are readily accessible through an extraperitoneal approach, tissue dissection is limited, and perioperative recovery resembles that of a routine inguinal hernia repair, with minimal postoperative morbidity and short hospitalization [5,14]. Several comparative studies have further suggested that distal UU may be associated with a less extensive surgical dissection and less severe complications than proximal reconstruction [10,15,16]. Another important reason for our preference for distal UU is the avoidance of a long residual ureteral stump, which may become symptomatic, particularly in the presence of upper moiety VUR. Nevertheless, even after distal UU, we observed in our study one patient with recurrent UTIs associated with reflux into a 2 cm distal ureteral stump. The potential morbidity of retained ureteral stumps has also been highlighted by Lee et al., who identified residual stump infection as a significant long-term complication after proximal UU, particularly in patients with markedly dilated upper pole ureters [17].

In patients with reflux into the recipient lower moiety ureter, our preferred approach has traditionally been common sheath ureteral reimplantation of both ureters rather than UU. Common sheath reimplantation remains a safe and technically straightforward procedure with low morbidity and excellent long-term outcomes that has successfully withstood the test of time [18]. Nevertheless, growing evidence suggests that lower moiety reflux may not necessarily represent an absolute contraindication to UU. Abdelhalim et al. reported good outcomes even in patients requiring concomitant lower tract reconstruction [13], while more recently Moreno Bencardino et al. demonstrated comparable postoperative outcomes and complication rates in patients undergoing UU despite ipsilateral lower pole reflux [19]. As only a single-cycle VCUG was routinely performed at our institution, some cases of vesicoureteral reflux may have remained undetected [20]. These findings suggest that the indications for distal UU may continue to expand, even in anatomical situations previously considered relative contraindications. If future studies continue to confirm the safety of distal UU in patients with ipsilateral lower moiety VUR, the routine use of preoperative VCUG, particularly in children without febrile UTIs or lower moiety ureteral dilatation, may warrant re-evaluation.

Even the routine need for lower moiety ureteral stenting during distal UU has increasingly been questioned. Historically, we routinely placed a lower moiety ureteral stent to facilitate intraoperative identification of the recipient ureter and to maintain ureteral patency during construction of the anastomosis. However, Wong and Braga demonstrated comparable outcomes between stented and stentless distal UU, while routine stenting was associated with a higher rate of minor complications and universally required a second

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procedure under general anesthesia for stent removal [14]. Furthermore, with the increasing adoption of minimally invasive surgery, laparoscopic and robot-assisted distal ureteroureterostomy have emerged as safe and effective alternatives to the open approach [21—24]. Comparative studies have demonstrated similar success and complication rates, with the potential advantages of reduced postoperative pain, shorter hospitalization, and faster recovery [21,23,25]. Although robotic surgery is currently not available at our institution, these minimally invasive approaches represent an important evolution in the surgical management of duplex kidney anomalies and are likely to play an increasingly important role.

A major concern associated with UU has always been the potential risk of compromising the recipient lower moiety through obstruction, recurrent infections, or "yo—yo" reflux. Our results demonstrate excellent preservation of the recipient lower moiety after distal UU, which is in agreement with contemporary reports demonstrating very low rates of clinically relevant obstruction or secondary surgery after UU [9,12,14]. Other recent studies with comparable follow-up have reported similar findings. Rodriguez et al. demonstrated excellent preservation of the recipient lower moiety after distal UU in a large multicenter cohort, while more recently Eftekharzadeh et al. confirmed the safety and durability of UU during follow-up extending up to 10 years after surgery [7,26]. In our study, only two children demonstrated mild asymptomatic lower moiety hydronephrosis with unobstructed drainage on postoperative scintigraphy, and no patient required reoperation. Whether these mild sonographic findings reflect clinically silent "yo—yo" reflux remains unknown. However, in the absence of symptoms, progressive hydronephrosis, or functional deterioration, we consider these findings clinically irrelevant.

The main limitations of our study are its relatively small cohort size and retrospective design. In addition, because our institution serves as a tertiary referral center for pediatric urology and receives patients from geographically distant regions, a proportion of children were lost to follow-up, as postoperative surveillance was frequently continued by local physicians closer to the family's residence. Nevertheless, the study also has several important strengths. All patients were treated using a standardized surgical technique, and follow-up was conducted according to a standardized protocol including serial ultrasound evaluation of the kidneys and urinary tract, allowing objective comparison of pre- and postoperative imaging findings. A median follow-up of 45 months provides valuable information regarding the postoperative safety and preservation of the recipient lower moiety. However, long-term studies with follow-up extending well into adulthood are still required to further evaluate the lifelong durability of this reconstructive approach.

Conclusion

Distal UU represents a safe, effective and definitive reconstructive option for children with duplex kidney anomalies and ectopic or obstructed upper moiety ureters. After a median follow-up of 45 months, no clinically relevant recipient lower moiety obstruction or reoperation was observed, supporting excellent preservation of the recipient lower moiety. Marked donor ureter dilatation and presumed poor upper moiety function did not adversely affect outcomes after surgery.

Informed consent

This is a retrospective study. For this type of study formal consent is not required.

Ethical approval

This retrospective study was reviewed and approved by the Ethics Committee of the University of Regensburg (No. 26-4671-104). All procedures were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

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Conflicts of interest

The authors declare that they have no conflict of interest to disclose.

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