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Extravesical Management of Complete Duplex Systems: A 4-Scenario Strategy

Mustafa OLGUNER
Dokuz Eylül University Faculty of Medicine
Oktay ULUSOY
oktay.ulusoy@deu.edu.tr

Dokuz Eylül University Faculty of Medicine
Oğuz ATEŞ
Dokuz Eylül University Faculty of Medicine
Berkay KASSER
Dokuz Eylül University Faculty of Medicine
Ayten BİLEN
Dokuz Eylül University Faculty of Medicine
Efil Aydın YILDIRIM
Dokuz Eylül University Faculty of Medicine
Feza Miraç AKGÜR
Dokuz Eylül University Faculty of Medicine

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Abstract

Purpose

Surgical reconstruction of complete duplex collecting systems (DCSs) in children involves significant anatomical complexity. Traditional intravesical procedures carry inherent risks of trigonal disruption and postoperative bladder morbidity. This study aimed to evaluate the efficacy, safety, and functional outcomes of an anatomically tailored, open distal extravesical surgical algorithm for complete DCSs without intravesical intervention

Methods

A retrospective review was conducted on 23 pediatric patients (median age: 11.0 months [IQR: 8.0–12.0]; 65.2% female) who underwent open retroperitoneal extravesical correction for complete DCSs between 2016 and 2026. Patients were stratified into four distinct anatomical scenarios: Group 1 (n = 6; bilateral non-dilated vesicoureteral reflux [VUR], treated with common-sheath extravesical reimplantation), Group 2 (n = 6; single pathological moiety with a non-refluxing counterpart, treated with distal ureteroureterostomy), Group 3 (n = 4; both moieties pathological without severe megaureters, treated with dismembered extravesical reimplantation plus ureteroureterostomy without tapering), and Group 4 (n = 7; bilateral megaureters, treated with excisional ureteral tapering, extravesical reimplantation, and ureteroureterostomy). All procedures were performed via a shortened Pfannenstiel incision strictly avoiding bladder entry.

Results

The overall median operative time was 120 minutes (IQR: 110–150). All reconstructive procedures were successfully completed retroperitoneally without intraoperative complications or conversions. Minor postoperative complications included transient gross hematuria in four patients (managed conservatively with intravenous hydration) and febrile urinary tract infections in two patients (resolved with targeted oral antibiotics). Serial postoperative ultrasonography demonstrated marked resolution of hydroureteronephrosis across all groups. No secondary VUR, ureteral stricture, or long-term sequelae occurred during follow-up.

Conclusion

There is no single corrective surgical procedure applicable to all patients with complete DCSs. Selection of the optimal extravesical technique should be individualized according to the anatomical characteristics of the anomaly, particularly the presence of VUR, involvement of one or both moieties, and the degree of ureteral dilatation.

Introduction

Duplex collecting systems (DCSs) constitute a common congenital urological anomaly, with a reported prevalence of approximately 1 in 125 live births, and may present with a broad spectrum of anatomical and clinical manifestations [1]. In complete DCSs, the upper and lower renal moieties are drained by separate ureters that insert independently into the bladder or, less commonly, at an ectopic location. In most cases, the ureteral insertion pattern follows the Weigert–Meyer rule, with the upper-moiety ureter inserting inferomedially and the lower-moiety ureter inserting superolaterally. Although many duplex systems remain asymptomatic, a wide spectrum of associated anomalies may involve one or both moieties, including vesicoureteral reflux (VUR), ureterocele and ectopic ureter. These abnormalities may present with a variety of clinical manifestations, ranging from continuous urinary incontinence and recurrent febrile urinary tract infections (UTI) to varying degrees of urinary tract obstruction. If left untreated, persistent obstruction, recurrent UTI, or VUR may lead to progressive renal parenchymal injury affecting either an individual moiety or the entire ipsilateral renal unit, resulting in long-term deterioration of renal function [1].

Management of complete DCSs broadly relies on either ablative or corrective surgical strategies. While heminephrectomy remains a widely accepted option for severely dysplastic or poorly functioning moieties, the optimal management of these patients continues to be debated [2]. In contrast, when sufficient renal function is preserved, corrective procedures aimed at maintaining viable renal parenchyma including ureteral reimplantation and ureteroureterostomy are generally favored. Nevertheless, the choice of surgical technique is often influenced by surgeon preference, anatomical complexity, and the nature of the associated urinary tract anomaly [2]. Despite advances in corrective surgery, data regarding the outcomes of open distal extravesical corrective procedures in children with complete DCSs remain limited. Therefore, the present study aimed to evaluate the surgical outcomes of open distal extravesical corrective surgeries for complex urinary tract anomalies associated with complete DCSs.

Methods

This study was approved by the Clinical Research Institutional Ethics Review Board (2026/22 – 15). The present study includes both male and female genders. We retrospectively reviewed demographic characteristics, records and imaging, operations performed, short and long term complicatons of children who underwent open distal extravesical corrective surgeries for complete DCSs between 2016 and 2026.

The study included patients who underwent open distal extravesical corrective surgeries due to complex urinary problems (VUR, ureterocele, or ectopic ureteral insertion) associated with a complete DCSs. Patients with unilateral or bilateral urinary problems accompanied by incomplete DCSs and single collecting systems were excluded from the study. To ensure a homogeneous study population, patients who underwent high urinary tract corrections beyond the extravesical region, intravesical reconstructive

procedures, procedures performed laparoscopically, or conversion from laparoscopy to open surgery were excluded from the study. The severity of VUR is categorized into five grades (I–V) according to the degree of dilatation of the ureter, renal pelvis, and calyces [3]. Assessment of renal parenchymal damage and renal function was performed using 99mTc-dimercaptosuccinic acid (DMSA) scintigraphy [4] and/or mercaptoacetyltriglycine (MAG-3) diuretic renography [5], according to disease characteristics and the clinician's preference.

Patients were categorized into four groups according to their urinary abnormalities:

Group 1. The patients with VUR to both moiety without significant ureteral dilatation.

Group 2. In complete DCSs, one moiety is typically unaffected, while the other moiety is associated with pathological conditions such as VUR, ureterocele, or ectopic ureteral insertion. The involved moiety may present with or without dilatation depending on the underlying pathology.

Group 3. In this group, both moieties were pathological. One moiety was dilated due to high-grade VUR, ureterocele, or ectopic ureteral insertion, while the other moiety had VUR and was either of normal caliber or mildly dilated, without the need for ureteral tapering.

Group 4. The patients with complete DCSs in whom both moieties were associated with megaureter accompanied by high-grade VUR, ureterocele, or ectopic ureteral insertion. Ureterovesical reimplantation must be performed with ureteral tapering.

Surgical procedures performed on the groups

All procedures were performed after confirming the absence of UTI on urine urinalysis and urine culture. Ampicillin plus sulbactam (50mg/kg) was administered as prophylactic antibiotic therapy per-operatively. Pediatric cystoscopes (Karl Storz GmbH & Co KG) were used for the intraoperative cystoscopy procedure and retrograde pyelography was routinely performed to detailing anatomy. Following completion of cystoscopy in the lithotomy position, the patients were repositioned to the supine position. Following skin preparation with 10% povidone-iodine and sterile draping, a sterile urethral catheter was inserted into the bladder, and its sterile distal end was incorporated into the operative field. In all cases, a shortened Pfannenstiel incision was used, tailored according to the side of the pathology. All procedures were performed retroperitoneally. In present series, excisional tapering was routinely performed over a 12-F catheter, followed by closure with running and interrupted 5 – 0 polyglactin (Vicryl®) sutures. After tapering is completed, the 12-F catheter was removed and an appropriately sized double-J stent was inserted into the tapered ureter.

For Group 1, after medial retraction of the bladder, both distal ureters of DCSs were suspended using cotton tapes. Dissection was carried out cranially and caudally to the ureterovesical junction while preserving the common sheath. Common sheath ureteral reimplantation was performed in accordance with the fundamental principles of the Lich Gregoir technique (Fig. 1) [6].

For group 2, during cystoscopy, a double-J catheter was placed into the non-refluxing ureter that was considered normal. After medial retraction of the bladder, both distal ureters of DCSs were suspended using cotton tapes. Dissection was extended both cranially and caudally to achieve full visualization of the ureterovesical junction. The pathological ureter was then transected just above the level of the common sheath (Fig. 2A and 2B). If reflux was present in the transected ureter, the distal segment was opened along its free wall down to the ureterovesical junction (Fig. 2A and 2B) and closed in a purse-string fashion (to avoid stump reflux) using a 4 – 0 polydioxanone (PDS) sutures placed through the ureteral mucosa (Fig. 2C). The portions outside the common sheath were excised and sent for pathological examination. In the absence of VUR, no intervention was performed on the distal ureteral stump. Subsequently, an end-to-side ureteroureterostomy was performed using 5 – 0 PDS sutures above the common sheath, and the procedure was completed (Fig. 2D). Surgical photographs are shown in Fig. 2E.

For group 3, In this group, unlike Group 2, anti-reflux surgery was performed because the normally calibrated ureter was associated with VUR. In these patients, both distal ureters of DCSs were suspended using cotton tapes (Fig. 3A) and transected just above the level of the common sheath (Fig. 3B). The common sheath was excised at the ureterovesical junction and preserved for pathological assessment (Fig. 3B). Both ureteral stumps were closed using 4 – 0 PDS sutures. Subsequently, detrusorotomy was performed according to the dismembered Lich-Gregoir technique (Fig. 3C). A double-J stent was inserted into the normally calibrated ureter, and ureteral reimplantation was completed with interrupted 5 – 0 PDS sutures (Fig. 3D). The detrusor muscle was then closed with interrupted 4 – 0 polyglactin (Vicryl®) sutures, completing the anti-reflux procedure. Finally, the dilated or non-dilated ureter was anastomosed end-to-side to the normally calibrated ureter via ureteroureterostomy (Fig. 3E). Surgical photographs are shown in Fig. 3F.

For group 4, both moieties of the DCSs presented as megaureters secondary to VUR, ureterocele, and/or ectopic ureteral insertion. After suspension of both ureters using cotton tapes (Fig. 4A), the ureters were dissected caudally to their most distal end, ligated with sutures at this level, and transected (Fig. 4B). The common sheath was excised, and preserved for pathological examination (Fig. 4B). Tapering of one of the mobilized ureters was performed over a 12F catheter (Fig. 4C). The catheter was then removed, and a double-J stent was inserted into the ureter. Following detrusorotomy according to Lich-Gregoir principles, ureteral reimplantation was performed 5 – 0 PDS sutures (Fig. 4D). The detrusor muscle was then closed with interrupted 4 – 0 polyglactin (Vicryl®) sutures, completing the anti-reflux procedure. The other megaureter was anastomosed end to side to reimplanted ureter without tapering, using 5 – 0 PDS sutures (Fig. 4E).

Follow-up

All patients underwent serial postoperative ultrasonographic examinations during follow-up. Patients who developed recurrent postoperative UTIs were further evaluated by voiding cystourethrography.

Statistical Analysis

Statistical analysis was performed using SPSS Software 23.0 (IBM Corp, Armonk, NY). Categorical variables were given as the number of cases and percentages. Continuous variables are expressed as median (25th-75th percentiles).

Results

A total of 23 patients were evaluated in this study [group 1, (n = 6); group 2, (n = 6); group 3, (n = 4); and Group 4, (n = 7)]. The median age of all patients was 11.0 (8.0–12.0) months. 65.2% of the patients were female, and the pathology was located on the left side in 69.5% of cases. The median operative time for the entire cohort was 120 minutes (110–150 minutes). The patients' demographic characteristics, laterality, and surgical indications are summarized in Table 1.

Table 1
Patient demographics and surgical indications

Groups	Age (month)/Gender/ Laterality (R/L)	Surgical Indication
Group 1 **(n = 6)**	9/F/L	Grade III VUR in both moieties; recurrent febrile UTIs; renal scarring on DMSA scintigraphy
	10/F/L	Grade IV VUR in the lower moiety and Grade III VUR in the upper moiety; renal scarring on DMSA scintigraphy
	11/M/L	Grade III VUR in both upper and lower moieties; recurrent febrile UTIs; renal scarring on DMSA scintigraphy
	16/F/R	Grade II VUR in the lower moiety and Grade III VUR in the upper moiety; recurrent febrile UTIs; renal scarring on DMSA scintigraphy
	17/M/L	Grade IV VUR in both moieties; renal scarring on DMSA scintigraphy
	24/F/R	Grade IV VUR in both moieties; recurrent febrile UTIs; renal scarring on DMSA scintigraphy
Group 2 **(n = 6)**	4/F/L	Upper moiety with ureterocele; reduced function on MAG-3 renography.
	8/F/L	Grade V VUR in the lower moiety; recurrent febrile UTIs and renal scarring on DMSA scintigraphy
	8/M/L	Upper moiety with ureterocele; reduced function on MAG-3 renography
	8/F/R	Upper moiety with ectopic ureteral insertion; reduced function on MAG-3 renography.
	10/F/R	Upper moiety with ectopic ureteral insertion; reduced function on MAG-3 renography
	48/F/L	Grade IV VUR in the upper moiety; recurrent febrile UTIs and renal scarring on DMSA scintigraphy
Group 3 **(n = 4)**	8/F/L	Grade IV VUR in one moiety; ectopic ureteral insertion in the other moiety
	10/M/L	Grade III VUR in one moiety; ureterocele in the other moiety
	18/M/R	Grade III VUR in one moiety; Grade V VUR in the other moiety
	36/F/L	Grade II VUR in one moiety; Grade V VUR in the other moiety
Group 4 **(n = 7)**	7/M/R	Complete DCS with obstructive pathology in both moiety: ureterocele in one moiety and ectopic ureteral insertion in the other moiety; bilateral obstructive pattern on MAG-3 renography; Megaureter in both moieties
	10/M/L	Ectopic ureteral insertion in one moiety; Grade V VUR in the other moiety; renal scarring on DMSA scintigraphy;

Groups	Age (month)/Gender/ Laterality (R/L)	Surgical Indication
		Megaureter in both moieties
	15/F/L	Grade V VUR involving both moieties; recurrent febrile UTIs; renal scarring on DMSA scintigraphy; megaureter in both moieties
	24/M/L	Grade V VUR involving both moieties; recurrent febrile UTIs; renal scarring on DMSA scintigraphy; Megaureter in both moieties
	48/F/L	Grade V VUR involving both moieties; recurrent febrile UTIs; renal scarring on DMSA scintigraphy; Megaureter in both moieties
	50/F/R	Complete DCS with obstructive pathology in both moiety: ureterocele in one moiety and ectopic ureteral insertion in the other moiety; bilateral obstructive pattern on MAG-3 renography; Megaureter in both moieties
	60/F/L	Grade V VUR involving both moieties; recurrent febrile UTIs; renal scarring on DMSA scintigraphy; Megaureter in both moieties

In *Group 1*, Six patients underwent common sheath ureteral reimplantation for VUR involving both moieties, accompanied by recurrent febrile urinary tract infections and renal scarring demonstrated on DMSA scintigraphy. Four of these patients had previously undergone two STING (subureteral Transurethral Injection) procedures for both moieties using Dextranomer/hyaluronic acid copolymer (Dx/HA; Dexell®). In one patient, common sheath anti-reflux surgery was performed as the primary intervention because the anatomical configuration was not suitable for STING injection, while in another patient, surgery was undertaken as the initial treatment based on parental preference.

The median operative time was 105 minutes (87.5–120 minutes). No intraoperative complications were observed in any patient. None of the patients required placement of a double-J ureteral stent. Urethral catheters were removed at postoperative 24 hours, and all patients were discharged on postoperative day 2. No cases of early postoperative hematuria or urinary retention were observed. No long-term complications occurred during follow-up.

In *Group 2*, six patients underwent extravesical ureteroureterostomy without ureteral reimplantation. Regarding the pathology of the affected moiety, two patients had high-grade VUR, whereas four patients had ectopic ureteral insertion (n = 2), ureterocele (n = 2) (Table 1). A double-J ureteral stent was placed to normal caliber non-refluxing ureter in all patients. No intraoperative complications occurred. The median operative time was 120 minutes (107.5-122.5 minutes). Postoperatively, one patient developed macroscopic hematuria, which resolved with conservative management and adequate hydration by postoperative day 3. The Foley catheter was removed at 24 hours postoperatively in five patients and at 72 hours in one patient. No cases of postoperative urinary retention were observed. All patients were discharged 24 hours after catheter removal. The double-J ureteral stents were removed at the first

postoperative month. All patients demonstrated favorable outcomes without long-term complications during follow up.

In *Group 3*, four patients underwent ureteral reimplantation combined with ureteroureterostomy without ureteral tapering. In this group, two patients underwent surgery for VUR involving both moieties, whereas two patients had VUR in one moiety and ureterocele or ectopic ureteral insertion affecting the other moiety (Table 1). A double-J ureteral stent was placed in the normally calibrated ureter without the need for tapering, followed by ureterovesical anastomosis. The median operative time was 140 minutes (122.5–170 minutes). No intraoperative complications occurred in any of the patients. Foley catheters were removed at 48 hours postoperatively in all cases. No episodes of hematuria or urinary retention were observed. One patient developed a urinary tract infection with fever during the first postoperative week. Following one week of appropriate antibiotic therapy, the double-J ureteral stent was removed at postoperative second week. The other three patients, the stents were removed at the first postoperative month. No long-term complications were observed during follow-up.

In *Group 4*, seven patients underwent ureteral tapering combined with ureteral reimplantation and ureteroureterostomy. In this group, four patients underwent surgery because of Grade V VUR involving both moieties, accompanied by megaureter in both moieties, whereas the remaining three patients underwent the same procedure because of ureterocele or ectopic ureteral insertion associated with megaureter in both moieties (Table 1). The median operative time was 155 minutes (150–180 minutes). In four patients, the Foley catheter was removed at 48 hours postoperatively, and these patients were discharged on postoperative day 3.

In the remaining three patients, gross hematuria developed postoperatively and was managed conservatively with adequate hydration and close observation. In this subgroup, the Foley catheter was removed on postoperative days 3, 4, and 6, respectively, and the patients were discharged one day after Foley catheter removal. One patient with postoperative hematuria subsequently developed a febrile UTI at postoperative first week, which was treated with a one-week course of antibiotics; the double-J stent was removed at the end of treatment. In the remaining six patients, the double-J stents were removed at postoperative one month.

An obstructive ureterocele was identified in four patients, all of whom were initially managed with primary endoscopic ureterocele incision; notably, none of the subsequent corrective surgical procedures required further intervention directed at the ureterocele.

Serial postoperative ultrasonography demonstrated marked resolution of hydroureteronephrosis across all groups. All patients remained asymptomatic without long-term complications during follow-up.

Discussion

The clinical presentation of complete DCSs is largely determined by associated urinary tract abnormalities, most commonly VUR, ureterocele, ectopic ureteral insertion (7,8). Management of

complete DCSs in children is challenging, and the decision between upper tract, lower tract, or combined surgical approaches is influenced by several factors, including associated anomalies such as VUR, differential renal function, clinical presentation, and surgeon experience. The principal objectives of treatment are preservation of renal function and prevention of recurrent febrile UTIs [9].

The principal corrective surgical options for the management of DCSs include partial nephrectomy, ureteroureterostomy and ureteral reimplantation [10, 11]. Partial nephrectomy has been widely adopted because it can be performed through open, laparoscopic, or robotic approaches and provides definitive treatment by completely removing the affected moiety. The primary rationale for this approach is the presence of varying degrees of dysplasia within the affected moiety [12]. However, dysplastic changes within the affected moiety appear to be uncommon [11]. Furthermore, the potential consequences of leaving dysplastic renal tissue in situ, including UTIs, hypertension, and malignant transformation, remain controversial. In this regard, Husmann suggested that surgical extirpation should not be justified solely by the presence of dysplastic renal tissue [13]. Historically, surgical extirpation represented the standard approach for presumed dysplastic moieties; however, for the reasons outlined above, corrective surgical procedures have emerged as a serious alternative to heminephrectomy in such cases [14–16]. The presence of concomitant VUR represents another challenge in patients undergoing partial nephrectomy. In patients with VUR, closure of the distal ureteral stump as close to the bladder as possible has been recommended to minimize the risk of a retained refluxing ureteral remnant acting as a urinary reservoir and predisposing to recurrent UTI. In patients undergoing partial nephrectomy with concomitant VUR, complete ureterectomy to avoid leaving a refluxing ureteral stump may be technically demanding. By contrast, extravesical corrective procedures allow complete visualization of the ureterovesical junction, facilitating secure management of the distal ureter and minimizing concerns related to a retained ureteral stump. On the other hand, partial nephrectomy, carries risks to damage to the healthy moiety and the need to treat existing or possible VUR in the remaining moiety later. Total correction procedures may also involve complex intravesical procedures that sometimes require a partial nephrectomy. Intravesical procedures in which performed total correction are ureterocele repair and antireflux surgeries, which sometimes require tapering. If the patient has an ectopic ureter, attempting to release ectopic ureters via the intravesical route, however, carries the risk of potentially damaging the sphincter mechanism. Because of these complex features of intravesical total correction, these procedures are not commonly performed today.

Ureteroureterostomy can be performed using either high (level of renal hilum) or distal anastomosis (above the common sheath). Both techniques can be performed using minimally invasive approaches such as robotic and laparoscopic surgery. However, both approaches require advanced training and skill in endoscopic surgery. Furthermore, in cases where the recipient ureter has VUR it is difficult to correct VUR of the recipient ureter via this route. To maintain a minimally invasive approach, performing a sting procedure on the recipient ureter following a ureteroureterostomy may be an option when the anatomy of the ureteral orifices is suitable. However, in cases where open surgery is necessary, the corrective methods we employ appear advantageous because they allow for control of the ureterovesical junction without opening the bladder, avoid complex intravesical common sheet ureteral reimplantations, and

prevent the procedures from becoming more complex and prone to complications particularly in cases where tapering is required.

In our corrective surgical management of complete DCSs, we employed common-sheath ureteral reimplantation, ureteroureterostomy, and reconstruction of the duplex system into a single ureter followed by ureteral reimplantation (Figs. 1–4). When the key technical considerations were evaluated, the defining feature of Group 1 was the presence of refluxing ureters with an anatomical caliber that did not require tapering, allowing common-sheath ureteral reimplantation to be performed. In Group 2, distal ureteroureterostomy was reserved for patients with a normal, non-refluxing recipient moiety and ureter. While ureteral dilatation of the affected moiety did not alter the operative strategy, the presence of VUR required meticulous excision of the distal ureteral stump without compromising the common sheath, followed by intraluminal purse-string closure. In contrast, when VUR was absent in the pathological moiety, simple transection and excision at the level of the common sheath were considered sufficient. In Groups 3 and 4, the DCSs were reconstructed into a single ureteral unit prior to reimplantation. The principal difference between these two procedures was the presence of megaureter involving both moieties. When both ureters were dilated, ureteral tapering became an essential component of the reconstructive procedure to facilitate successful reimplantation. Comparison of the study groups demonstrated that the principal determinants of operative duration were reconstruction of the duplex system into a single ureteral unit and the requirement for ureteral tapering. Accordingly, these procedures were associated with longer operative times.

In the surgical management of children presenting with complete DCSs, our approach of avoiding routine intravesical or extravesical ureterocele repair or excision is consistent with current clinical data supporting less invasive strategies [17]. Ureterocele incision or punctre is a widely accepted treatment as an initial therapy in patients with complete DCSs associated ureterocele. The majority of ureteroceles that have undergone prior transurethral incision typically demonstrate spontaneous regression over time once adequate decompression of the urinary system is achieved, without predisposing patients to significant recurrent obstruction or major clinical sequelae during long term follow-up. [18, 19]. Leaving decompressed ureterocele remnants in situ is safe and significantly lowers the requirement for highly morbid secondary lower urinary tract reconstructions, such as formal bladder neck reconstruction or complex ureterocelectomy [17, 20]. However, while this treatment is successful in half of the patients who undergo ureterocele incision as an initial treatment, the other half develop VUR, drainage problems and UTIs [17–20]. We also performed ureterocele incision as the initial treatment for our patients with ureterocele. Consequently, leaving ureterocele remnants in extravesical corrective surgeries minimizes operative duration, prevents unnecessary mucosal disruption, and preserves the structural and anatomical integrity of the bladder trigone.

The present study is limited by its retrospective design, the inclusion of different extravesical corrective surgeries, and the relatively small sample size inherent to the rarity of complete DCSs requiring surgical reconstruction. Therefore, prospective multicenter studies with larger patient cohorts and longer follow-up are needed to validate these findings and better define the long-term outcomes of corrective surgery

for complete DCSs. Another limitation is the lack of laparoscopic and robotic procedures in the present series. This is attributable to our institutional preference for reserving laparoscopic surgery for upper urinary tract reconstruction and the unavailability of a robotic surgical platform at our institution.

Conclusion

There is no single corrective surgical procedure applicable to all patients with complete DCSs. Selection of the optimal extravesical technique should be individualized according to the anatomical characteristics of the anomaly, particularly the presence of VUR, involvement of one or both moieties, and the degree of ureteral dilatation. In appropriately selected patients, open extravesical corrective surgery enables effective reconstruction through a small incision without opening the bladder while preserving function.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and was approved by the Dokuz Eylül University Clinical Research Ethics Committee (approval number: 2026/22 – 15). The requirement for informed consent from parents or legal guardians was waived by the ethics committee.

Consent for publication

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

Declarations of generative AI use

During the preparation of this work, the authors used ChatGPT for language editing. ChatGPT was not used for the design or conduct of the research, data analysis, interpretation of the results, or generation of scientific content.

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Author Contribution

All authors wrote the main manuscript text and E.A.Y. prepared figures 1-4. All authors reviewed the manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Abbreviations

Duplex collecting systems (DCSs)

Vesicoureteral reflux (VUR)

Urinary tract infections (UTI)

99mTc-dimercaptosuccinic acid scintigraphy (DMSA)

Mercaptoacetyltriglycine diuretic renography (MAG-3)

Subureteral Transurethral Injection (STING)

Polydioxanone sutures (PDS)

Dextranomer/hyaluronic acid copolymer (Dx/HA).

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Figures

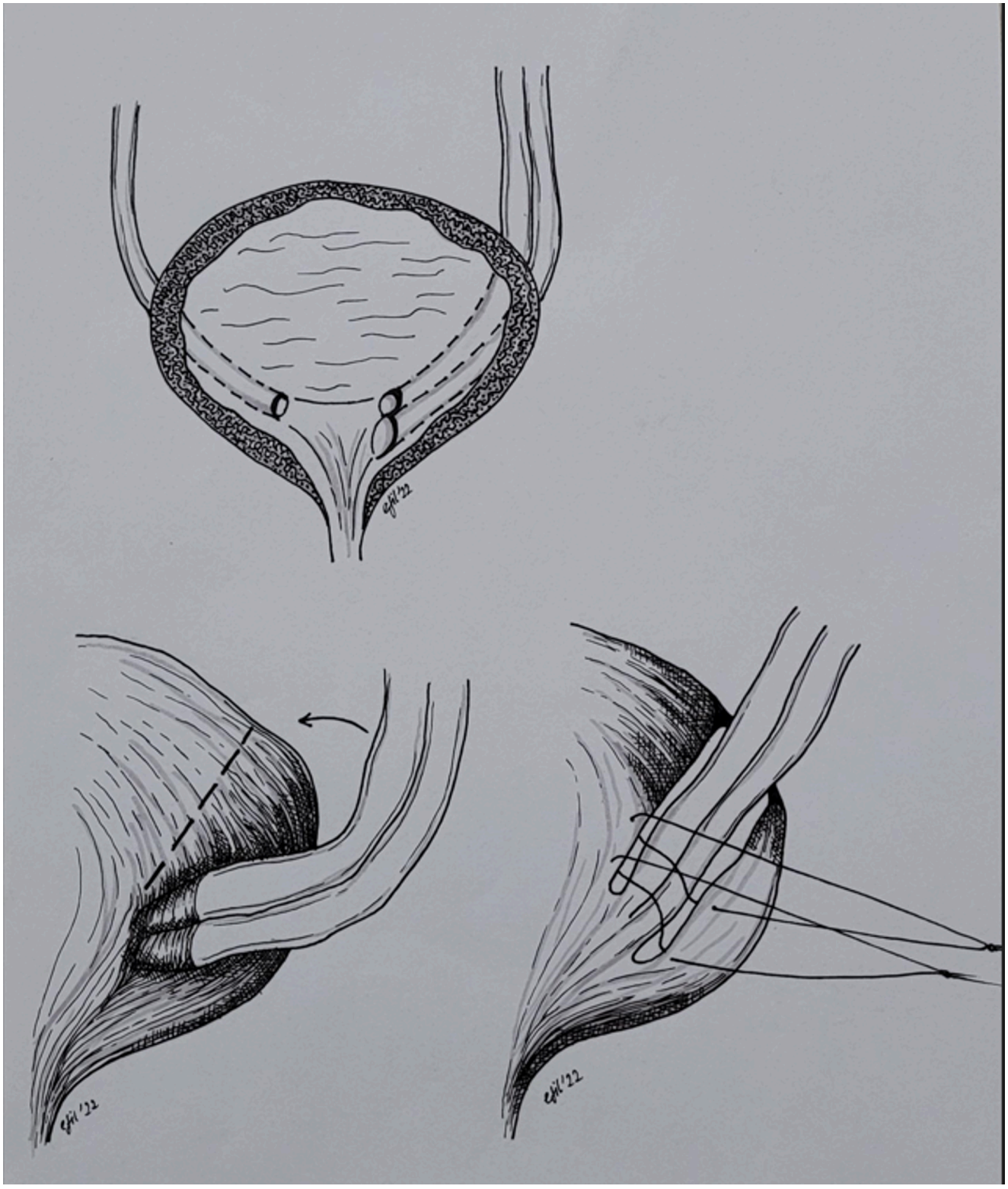


Figure 1

A schematic illustration of the corresponding surgical procedure.

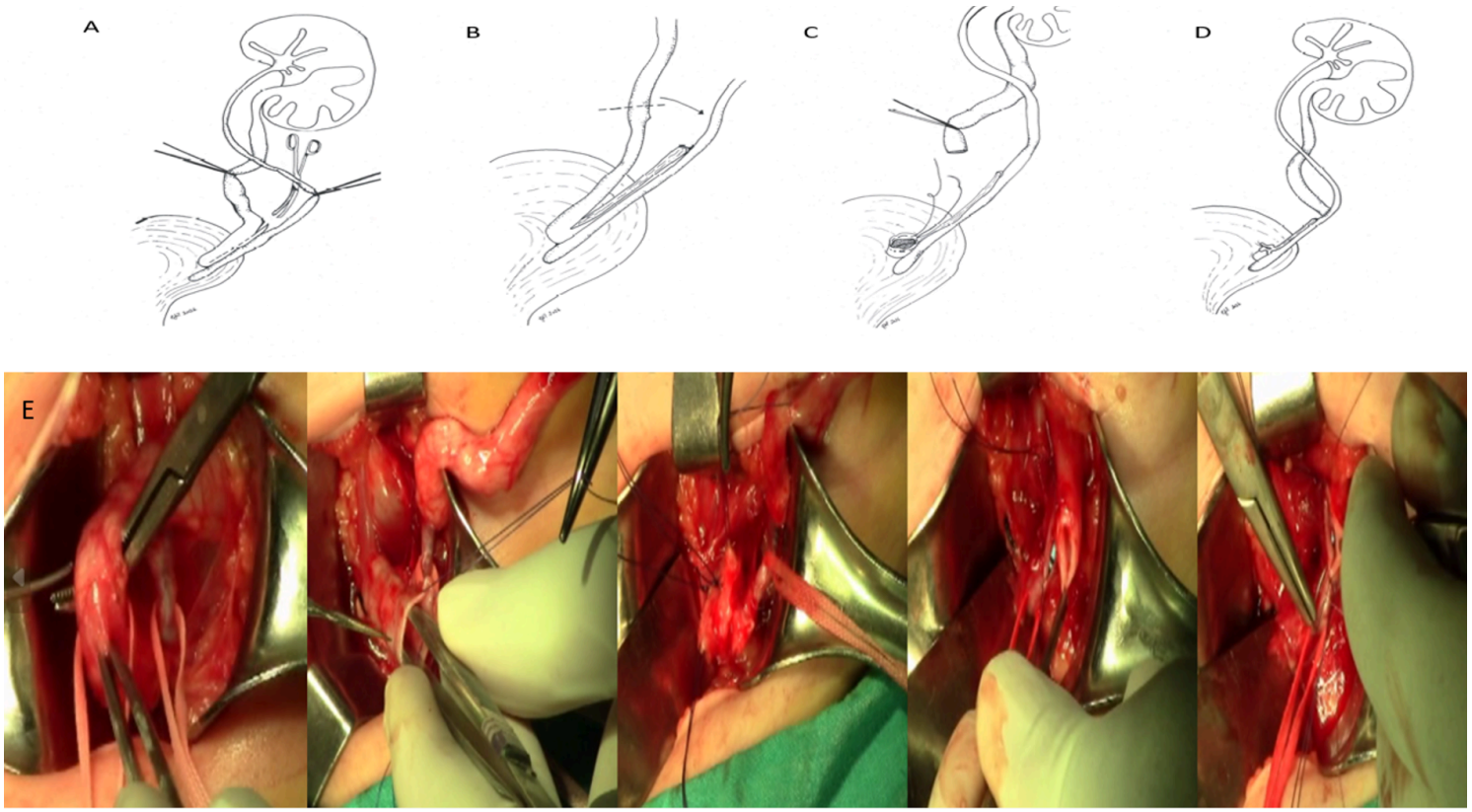


Figure 2

Surgical steps of distal ureteroureterostomy. (A) The pathological ureter was then transected just above the level of the common sheath. (B) If vesicoureteral reflux was present, the distal ureteral stump was longitudinally opened along its free wall down to the ureterovesical junction. (C) The distal stump was subsequently closed with an intraluminal purse-string 4-0 PDS suture placed through the ureteral mucosa. (D) An end-to-side ureteroureterostomy was performed proximal to the common sheath using interrupted 5-0 PDS sutures. (E) Representative intraoperative photographs demonstrating the key steps of the procedure.

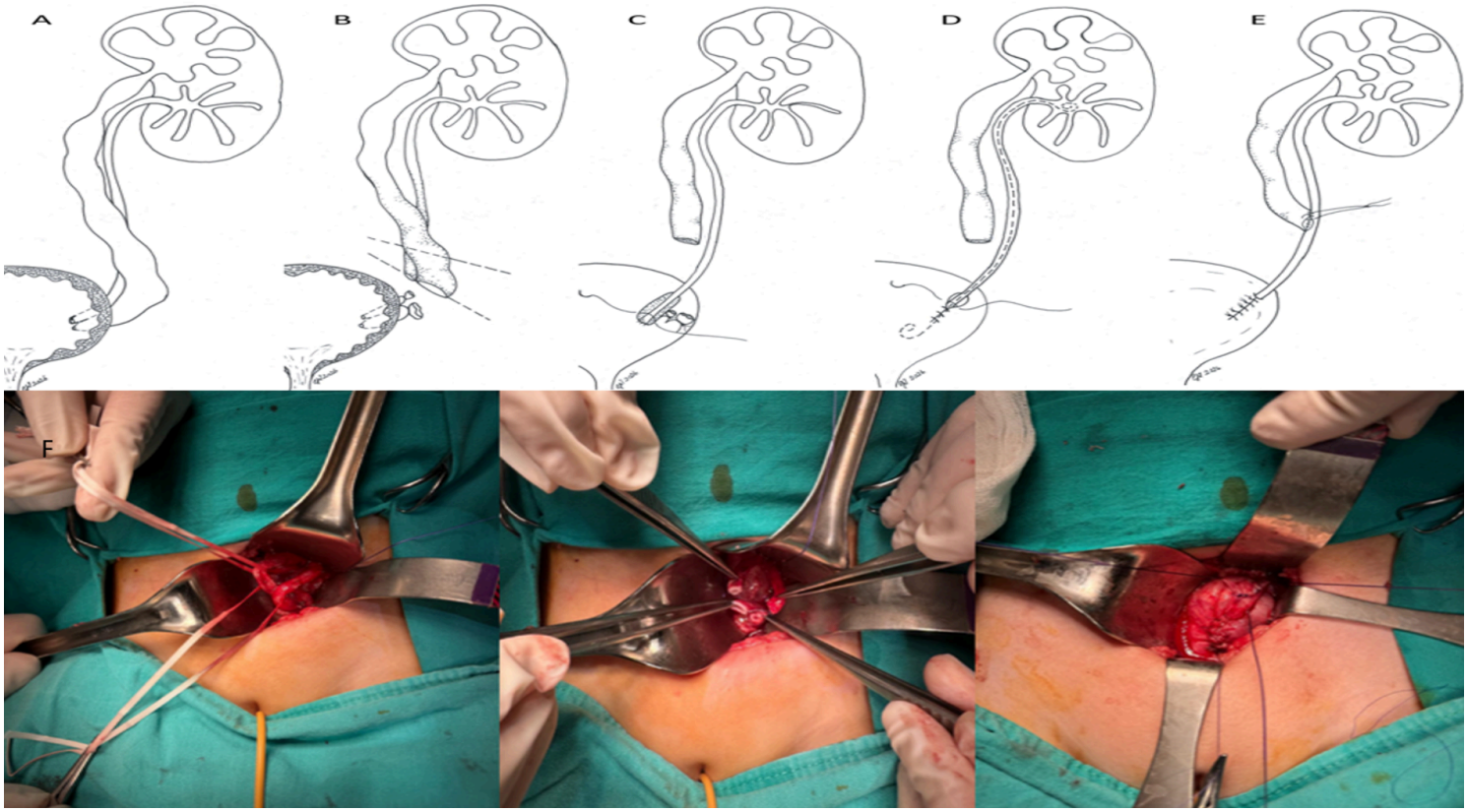


Figure 3

Surgical steps of ureteral reimplantation combined with distal ureteroureterostomy. (A) Both distal ureters of the duplex collecting system were suspended using cotton tapes. (B) The ureters were transected just above the level of the common sheath. (C) Detrusorotomy was performed according to the dismembered Lich–Gregoir technique. (D) Ureteral reimplantation was completed using interrupted 4-0 PDS sutures. (E) End-to-side ureteroureterostomy was performed between the dilated and normally calibrated ureters. (F) Representative intraoperative photographs demonstrating the key steps of the procedure.

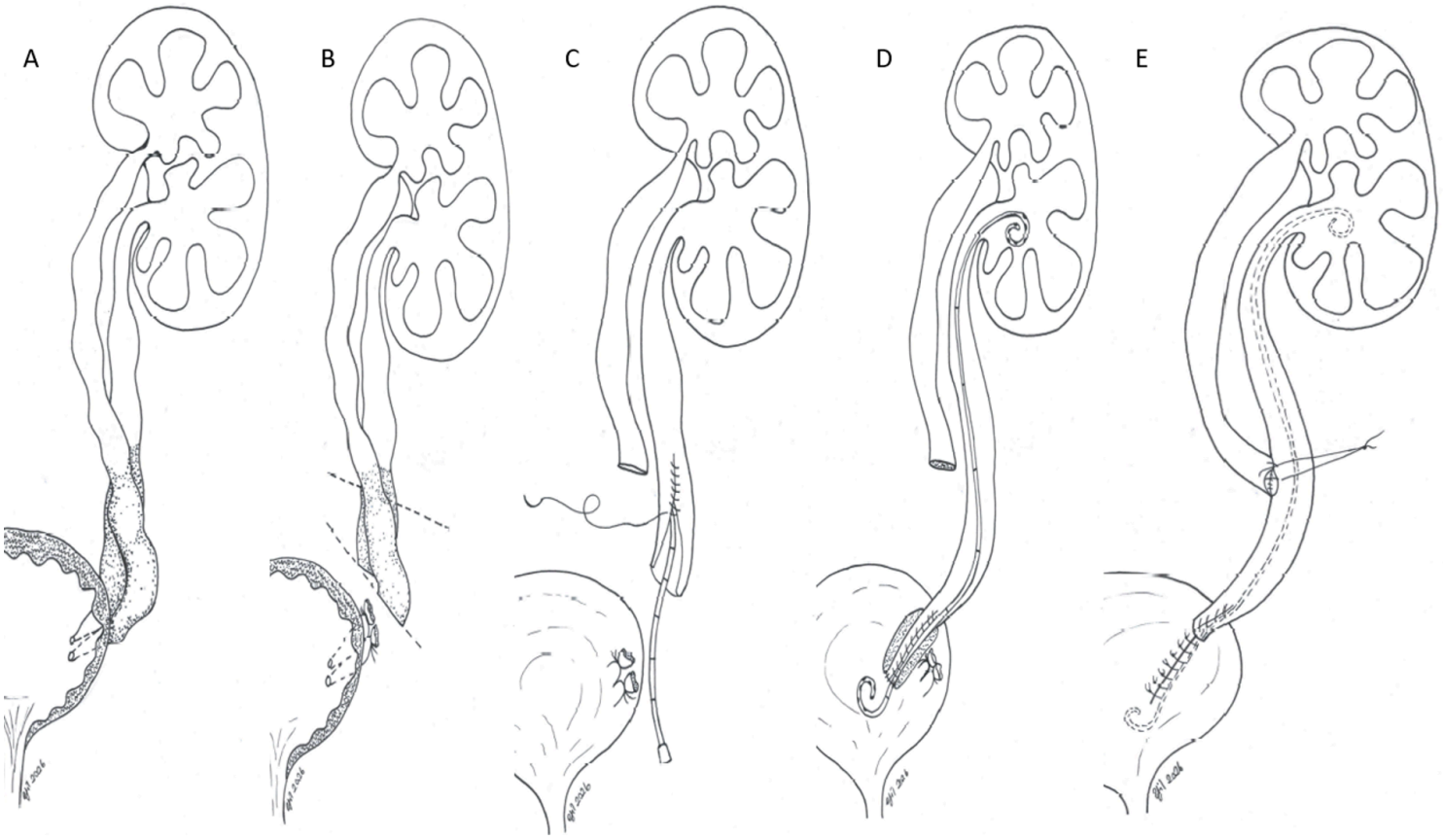


Figure 4

Surgical steps of ureteral reimplantation combined with ureteroureterostomy and ureteral tapering. (A) Suspension of both ureters using cotton tapes. (B) Distal dissection and transection of both ureters, followed by excision of the common sheath and closure of the ureteral stumps. (C) Tapering of the dilated ureter over a 12F catheter. (D) Ureteral reimplantation following detrusorotomy. (E) End-to-side ureteroureterostomy between the tapered and non-tapered ureters.