Original Article

Surgical Management of Complicated Duplex Kidney: A Tertiary Referral Centre 10-Year Experience

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Abstract

Aim: The management of a complicated duplex kidney remains a challenge for paediatric urologists. The aim of this study is to report a 10-year experience of the surgical management of complicated duplex kidney in a single tertiary care paediatric referring hospital. **Materials and Methods:** Clinical records of all children who undergone a surgical procedure for complicated duplex systems between January 2009 and March 2019 at our institution were retrospectively reviewed. Clinical manifestations, surgical procedures, complications and follow-up were collected and analysed. Logistic regression was performed to explore if any patient's characteristic or underlying associated comorbidity (ureterocoele, ectopic ureter, obstruction, etc.,) could be positively linked to the chance to develop recurrent urinary tract infections (UTIs). **Results:** We have identified 95 children who received a surgical treatment for 102 complicated duplex kidneys. The presence of an ureterocoele was recorded in 41 (43.2%) patients, an ectopic ureter in 25 (26.3%), a vesicoureteral reflux (VUR) in 40 (42.1%), a vesicoureteric junction obstruction in 24 (25.3%) and an ureteropelvic junction obstruction in 3 (3.2%). An invasive approach such as an heminephrectomy (71.6%) was required in the majority of cases. Higher risk of developing a UTI has been demonstrated in children diagnosed postnatally ($P < 0.001$) and in those with an associated obstruction ($P < 0.05$). **Conclusions:** No standardised management could be recommended for the surgical treatment of complicated duplex kidney. Children without antenatal diagnosis and with either an upper tract obstruction or VUR are at greater risk to develop UTI and need to be looked after more closely.

Keywords: Duplex kidney, ectopic ureter, ureterocoele, urinary tract infections, vesicoureteral reflux

Introduction

Duplex kidney with ureteral duplication is one of the most common congenital anatomical variants affecting the genitourinary tract.[1] Although asymptomatic (non-complicated) duplications with normally developed renal moieties represent the vast majority, clinically significant associated anomalies, such as ectopic ureter, vesicoureteric reflux (VUR) and ureterocoele, could lead to complications such as urinary obstruction, recurrent urinary tract infections (UTI)[2] or incontinence.

Since patterns and indications for surgery vary widely in relation to clinical presentations and experience, several surgical options have been proposed with different success rates. Surgical interventions range from minor (endoscopic puncture of ureterocoele, etc.) to major procedures that can be either ablative (heminephrectomy) or reconstructive (ureteroureterostomy).

To date, only a few studies[3,4] focus on the global management of children with complicated duplex renal systems, while most of the published literature only focuses on one single underlying aspect.

The aim of the present study is to report our 10-year experience of surgical treatment of a complicated duplex kidney and to compare it with the available literature. For better clarity, we will also present and discuss the results divided by each underlying associated anomaly (ureterocoele, ectopic ureter, VUR, etc.,).

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Materials and Methods

Study design

We performed a retrospective review of medical records of all children aged ≤16 years who underwent surgical treatment for a complicated duplex renal system in our tertiary care paediatric referring hospital from January 2009 to March 2019.

Inclusion criteria were the presence of a 'complicated' duplex kidney requiring surgical intervention, with or without clinically significant associated anomalies, such as ectopic ureter, VUR and ureterocoele. Children with a "non-complicated" duplex or not requiring surgical intervention have not been included. Data regarding patients' characteristics such as gender, age, duplex kidney side, clinical presentation, associated anomalies, antenatal versus postnatal diagnosis and definitive treatment were recorded. Incidence and type of post-operative complications were recorded and classified according to the Clavien–Dindo scoring system.[5]

Statistical analysis

Data were entered into a Microsoft Excel (Version 14.0) database and then transferred to SPSS V25 (IBM Corp, Armonk, NY), company for Windows. Descriptive statistics were calculated for all demographic, treatment, clinical and follow-up variables and reported as median (first to third quartile) or as a proportion with percentage. Considering that, in our cohort of patients, acute UTIs represent the most common cause of non-elective hospitalisation, we tried to identify any possible risk factor.

A Pearson Chi-square test and a binary logistic regression analysis have been performed to explore if any patient's characteristic (gender, laterality, time of diagnosis) or underlying associated comorbidity (ureterocoele, ectopic ureter, obstruction, VUR) could be positively linked to recurrent UTIs.

Results

Demographics

We identified 95 children (37 males and 58 females) who underwent a surgical intervention for a complicated duplex kidney. Seven children had a bilateral duplex for a total of 102 renal units (50 right side and 52 left side) of which 6 were incomplete. In total, 119 procedures were carried out. The median follow-up after the last surgical procedure was 4.8 years (range: 6.9 month-11 years).

Initial clinical presentation was recorded in 87 patients: 53 (55.8%) had an antenatal diagnosis, in 25 (26.3%) the diagnosis of duplex followed a UTI, 5 children (5.3%) presented with incontinence, 1 (1.1%) with haematuria and 1 (1.1%) with lumbar pain. In the remaining two patients (2.1%), a complicated duplex renal system was discovered incidentally [Table 1]. In the group of patients with postnatal diagnosis (34 patients), median age at presentation was 4 years (range: 21 days–14.9 years).

Regarding the surgical management, 22 patients (23.2%) were approached endoscopically: Fourteen patients (14.7%) (15 renal units) underwent one or more transurethral ureterocoele incision (TUI) and eight patients (8.4%) (9 renal units) an endoscopic treatment of reflux (subureteral injection of deflux).

Table 1: Patients' demographics

Patients' characteristics	*n*=95, *n* (%)
Gender	
Male	37 (38.9)
Female	58 (61.1)
Side	
Right	43 (45.3)
Left	45 (47.4)
Bilateral	7 (7.4)
Clinical presentations	
Antenatal diagnosis	53 (55.8)
Urinary tract infections	25 (26.3)
Urinary incontinence	5 (5.3)
Haematuria	1 (1.1)
Pain	1 (1.1)
Incidental	2 (2.1)
Not determined (nd)	8 (8.4)
Underlying complication	
Ureterocoele	41 (43.2)
Ectopic ureter	25 (26.3)
VUR	43 (45.3)
VUJO	27 (28.4)
UPJO	4 (4.2)
Definitive treatment	
Endoscopic ureterocoele puncture	15 (14.7)
Transurethral ureterocoele Incision	9 (8.8)
Ureteroureterostomy	1 (1.0)
Common sheet ureteral reimplantation	10 (9.8)
Heminephrectomy	68 (66.7)
Nephrectomy	9 (8.8)
Pyeloplasty	3 (2.9)

VUR: Vesicoureteric reflux, VUJO: Vesicoureteric junction obstruction, UPJO: Uteropelvic junction obstruction

A more invasive surgical treatment was adopted in the majority of cases: an heminephrectomy was performed in 66 patients (69.5%) (a total of 68 renal units, 56 upper moieties and 12 lower moieties were removed) at median patient age of 19.5 months (range: 5 month–15.2 years). Of those patients, 19 (27.9%) were approached laparoscopically at a median age of 3.4 years (range: 6 month– 14.3 years). Nine patients (9.5%) required a nephrectomy, performed at median age of 5.8 years (range: 1 month – 10.7 years); in 4 (44.4%) cases, the procedure has been carried out laparoscopically at a median age of 6.3 years (range: 13 month – 7.8 years). Finally, three patients (3.2%) underwent a pyeloplasty and one child (1.1%), with an ectopic ureter, has undergone a ureteroureterostomy.

Considering only the definitive procedure performed, 13 renal units (13.7%) were treated endoscopically, while 91 underwent a major surgery (in 77 the surgery was ablative).

Overall, 6 children (6.3%) (6 surgical procedures) developed an early postoperative complication. All complications occurred following an open heminephrectomy (involving the upper moiety in 5 cases and the right side in 4 cases).

In all six patients, the indication for surgery was absence of function associated with the presence of an ureterocoele (3 cases), an isolated ectopic ureter (1 case), a VUR (1 case) and a ureteropelvic junction obstruction (UPJO) (1 case).

Complications were classified according to the Clavien–Dindo scoring system as Grade I in 2 cases (1 postoperative surgical site infection, 1 acute urinary retention requiring a catheter insertion), Grade II in 2 cases (postoperative infections requiring intravenous antibiotic therapy), Grade III b in 2 cases (2 acute kidney injuries associated with complete loss of function of the remaining moiety).

Given the complexity of this condition and to have a structured review of the results, an analysis was conducted based upon the underlying associated anomaly.

Ureterocoele

In 41 patients (43.2%) (14 males; 27 females), a total of 45 renal units (44.1%) (27 right side; 18 left side) were complicated by an ureterocoele: it affected the upper moiety of a complete duplex renal system in 43/45 cases (95.6%) and of an incomplete duplex renal system in the remaining 2/45 cases (4.4%).

The ureterocoele was associated with a vesicoureteric junction obstruction (VUJO) in 12 cases (26.7%), with an upper moiety VUR in 2 cases (4.4%) and with a lower moiety VUR in 15 cases (33.3%).

Data regarding initial clinical presentation were available in 39/41 patients (95.1%): Thirty (76.9%) were diagnosed antenatally, 8 (20.5%) following an UTI and 1 (2.6%) due to urinary incontinence.

The first surgical treatment was an endoscopic puncture in 15/45 cases (33.3%), a common sheath vesicoureteral reimplantation in 2/45 cases (4.4%), a heminephrectomy in 25/45 cases (55.6%) and a nephrectomy in 3/45 cases (6.7%) [Figure 1].

Of the 15 ureterocoeles initially approached endoscopically, 6 (40.0%) completely recovered, 2 (13.3%) required a second endoscopic puncture to achieve a complete recovery, 3 (20.0%) were followed by a heminephrectomy, 3 (20.0%) by a nephrectomy and in 1 (6.7%) patient two further endoscopic punctures and, eventually, an heminephrectomy were performed.

The final treatment was therefore an endoscopic puncture in 8/45 cases (17.8%), a heminephrectomy in 29/45 (64.4%), a nephrectomy in 6/45 (13.3%) and a common sheath vesicoureteric reimplantation in 2/45 (4.4%).

The indication for nephrectomy in all 6 cases was a non-functioning kidney complicated by recurrent UTIs. Three cases (50%) had associated high-grade reflux into the lower moiety.

The procedure was carried out laparoscopically in 10/45 cases (22.2%) (8 heminephrectomies and 2 nephrectomies), at a median age of 4.8 years (range: 6 month–12.0 years).

Postoperative complications occurred after an open heminephrectomy in 3 cases (6.7%): a surgical site infection (Clavien–Dindo Grade I), a postoperative sepsis requiring intravenous antibiotics administration (Clavien–Dindo Grade II) and an acute kidney injury associated with complete functional loss of the remaining lower moiety (Clavien–Dindo Grade III b).

Ectopic ureter

An ectopic ureter was identified in 25 renal units (24.5%) (11 right side; 14 left side) and in 25 patients (26.3%) (5 males; 20 females). It was related to the upper moiety of a complete duplex renal system in 24/25 cases (96.0%) and of an incomplete duplex renal system in the remaining one.

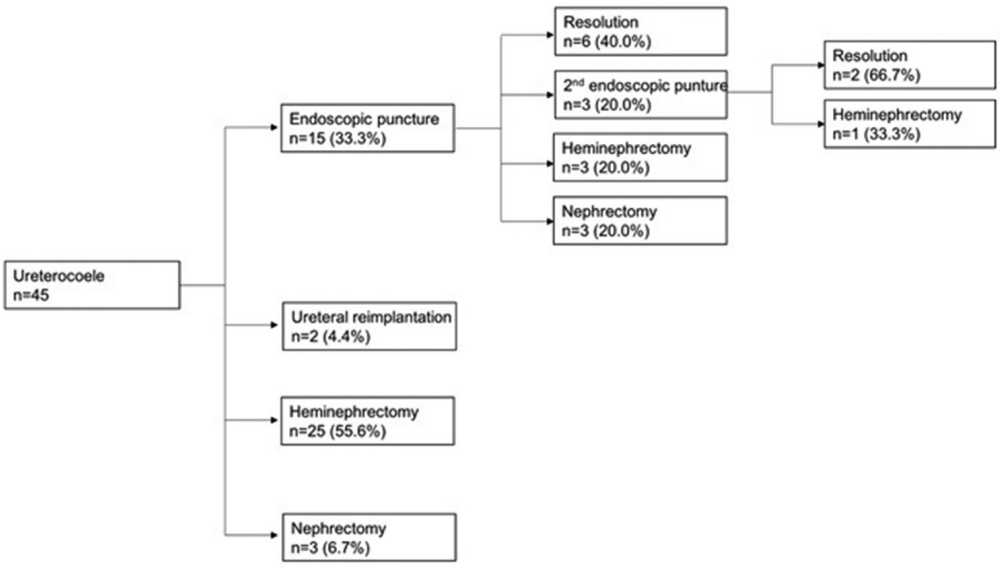


Figure 1: Management and outcome of ureterocoele in our cohort

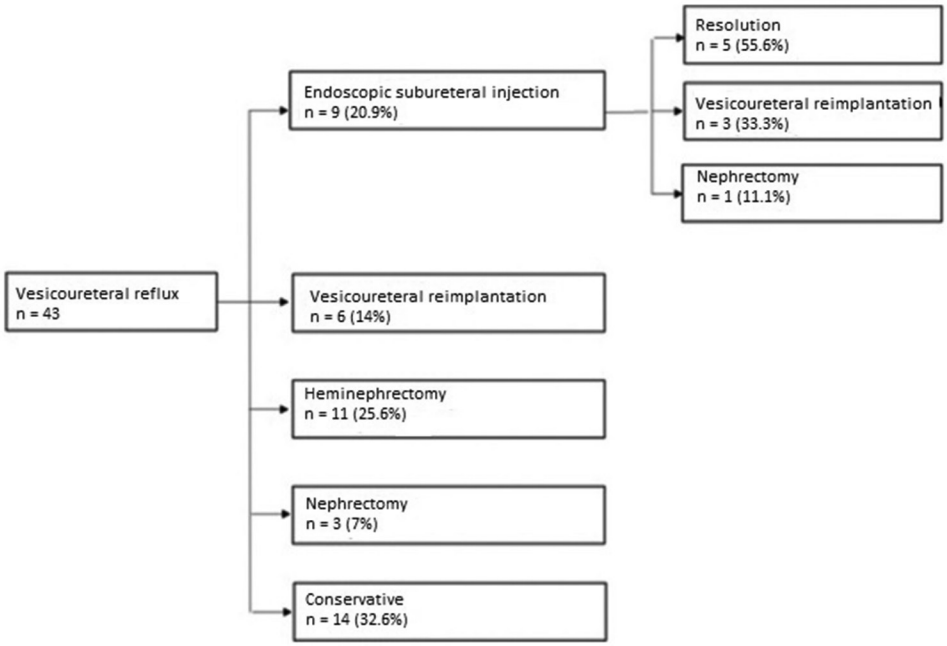


Figure 2: Management and outcome of vesicoureteric reflux in our cohort

Seven patients showed an associated VUJO, 6 had an associated ureterocoele whereas 3 patients had a VUR on the ipsilateral lower moiety ureter.

Data regarding initial clinical presentation were available in 23/25 (92.0%) patients: Fifteen (65.2%) were diagnosed antenatally, 4 (17.4%) following a UTI, 3 (13.0%) because of urinary incontinence and 1 (4.3%) due to haematuria.

Regarding surgical management, 22 children (88.0%) underwent a heminephrectomy at a median age of 1.5 years (range: 7 months– 12 years). The procedure was carried out laparoscopically in 8 cases (36.4%).

One Clavien–Dindo Grade III b complication occurred after an open procedure: an acute vascular injury associated with complete loss of function of the remaining lower moiety.

An uncomplicated laparoscopic nephrectomy was performed on a 14-month-old patient with recurrent UTIs to remove a non-functioning duplex kidney in which the upper moiety was associated with an ectopic ureter while the lower moiety was severely dilated.

The remaining 2 cases were treated respectively with an ureteroureterostomy and a common sheath vesicoureteral reimplantation (in both cases, the renal function of both moieties was preserved). No complications were recorded in any of the two.

Vesicoureteric reflux

In 43 renal units (42.2%) (21 right side; 22 left side) and 40 patients (42.1%) (20 males, 20 females), an associated VUR has been recorded. The lower moiety was affected in 40/43 cases (93.0%), the upper moiety in 1 case (2.3%) and both moieties in the remaining two patients (4.7%).

Data regarding initial clinical presentation were available in 36/40 patients (90.0%): 23 (63.9%) were diagnosed antenatally while the remaining 13 (36.1%) following a UTI.

Both refluxing upper moieties and 15 of the 41 refluxing lower moieties (36.6%) were associated with an ipsilateral ureterocoele.

Regarding surgical treatment, 9 units (20.9%) were firstly approached with an endoscopic subureteral injection, which succeeded in 5 cases (55.6%), was followed by a vesicoureteral reimplantation in 3 cases (33.3%) and by a nephrectomy in 1 case (11.1%) [Figure 2]. A primary common sheath vesicoureteral reimplantation was performed on 6 units (14.0%), a heminephrectomy on 11 (25.6%) and a nephrectomy on 3 (7.0%).

In the remaining 14 cases (32.6%), the VUR was conservatively managed (those patients are included in our cohort because they have undergone a surgical procedure related to the other moiety).

A single complication (acute urinary retention requiring insertion of a catheter, Clavien–Dindo Grade I) occurred following an open heminephrectomy.

Vesicoureteric junction obstruction

In 28 renal units (27.5%) (14 right side; 14 left side) and 27 patients (25.3%) (10 males, 17 females), the duplex kidney was complicated by a VUJO that affected only the upper moiety in 22 cases, only the lower moiety in 3 cases and both moieties in the remaining 3 cases.

It was associated with an ureterocoele in 10 cases (35.7%), with an ectopic ureter in 4 cases (14.3%), with an ectopic ureterocoele in 2 cases (7.1%) and with a ipsilateral lower moiety VUR in 5 cases (17.9%).

Table 2: Investigated risk factors for urinary tract infection development

Risk factor	UTI yes (*n*=54)	UTI no (*n*=34)	Overall (*n*=88)	*P*
Gender				
Male	19	14	33	0.50
Female	35	20	55	
Laterality				
Right side	21	18	39	0.43
Left side	27	15	42	
Bilateral	6	1	7	
Antenatal diagnosis				
Yes	27	25	52	<0.001
No	26	8	34	
Not determined	1	1	2	
Underlying diagnosis				
Ureterocoele	24	14	38	0.95
Ectopic ureter	13	10	23	0.84
VUR	27	9	36	0.06
VUJO	14	13	27	0.10
UPJO	0	4	4	<0.05

UTI: Urinary tract infection, VUR: Vesicoureteric reflux, VUJO: Vesicoureteric junction obstruction, UPJO: Uteropelvic junction obstruction

Data regarding initial clinical presentation were available in 26/27 (96.0%) patients, 14 patients (53.9%) were diagnosed antenatally, 7 (26.9%) following a UTI, 2 (7.7%) because of incontinence, 1 (3.9%) due to haematuria and 2 (7.7%) were discovered incidentally.

The definitive surgical treatment was an endoscopic puncture of the associated ureterocoele in 3 cases (10.7%) and a heminephrectomy in 22 cases (78.6%). A nephrectomy was performed in three patients (10.7%) due to a complete loss of function of the ipsilateral kidney: the nephrectomy was the first-choice surgery in 1 child, while in the remaining two patients was performed following a failed endoscopic treatment.

Ureteropelvic junction obstruction

Four renal units (3.9%) (2 right side) and four patients (4.2%) (3 males) were complicated by a pelvic dilatation secondary to UPJO.

The lower moiety was affected in 3 children and the upper moiety in one child and was associated with an incomplete duplex system in two patients.

Among the four patients, three had an antenatal diagnosis and one was diagnosed following episodes of lumbar pain.

In three patients, a pyeloplasty was performed without complications. One patient underwent an upper pole heminephrectomy and developed a postoperative fever secondary to pulmonary atelectasis requiring intravenous antibiotics (Clavien–Dindo Grade II).

Urinary tract infections

In 54 of the 88 patients (61.4%) of whom clinical information were available, a history of recurrent UTIs was recorded.

The binary logistic regression analysis demonstrates that the absence of an antenatal diagnosis and presence of an associated underlying diagnosis of UPJO are independent predictors of developing UTIs ($P < 0.05$ and $P < 0.0001$, respectively) [Table 2]. The presence of a VUR increased the risk of developing UTIs although the numbers did not reach statistical significance ($P = 0.066$).

Discussion

Duplex renal anomaly is a common congenital urological defect recorded in about 0.8% of population.[1] Although clinically silent ureteral duplication represents the vast majority (uncomplicated duplex), an association with an ectopic ureter, ureterocoele, ureteral obstruction and VUR can lead to increased risk of complications such as recurrent UTIs, incontinence and renal impairment in a non-negligible percentage of cases.

Since demonstrated standardised guidelines and management strategies are lacking, only individualised treatments have been proposed so far.

We presented, to the best of our knowledge, the largest single-centre paediatric series of surgically treated complicated duplex renal units and provided a general overview of management and outcomes. A literature review was also performed to compare our results with published reports.

Urinary tract infections

Rodrigues *et al*.[3] analysed clinical records of 32 patients who have undergone surgery for a complete ureteral duplication. Similarly to our cohort, an antenatal diagnosis was available in the majority (65.6%) of their patients and authors suggested that an early diagnosis was associated with better prognosis, since it prevented recurrent UTIs, with consequent impairment of the renal function. In line with these results, in our cohort, the presence of an antenatal diagnosis was significantly associated with a lower incidence of UTIs ($n = 27/53$, 50.9% versus $n = 26/34$ 76.5%, $P < 0.01$).

Two other conditions found associated with higher risk of developing UTI in our cohort were the presence of a upper tract obstruction pelviureteric junction obstruction and the presence of vesicoureteric reflux. The latter, in particular, was expected due to the known association with increased risk of both UTI and renal scarring, however, it did not reach statistical significance.[6]

Vesicoureteral reflux and ureterocoele

VUR is referred to as the anomaly most commonly associated with renal duplex systems: it affects the laterally displaced lower pole ureter in 90% of cases in keeping with the Weigert-Meyer rule[7,8] while it can complicate an upper pole ureterocoele in up to 50% of cases. Findings in our cohort are in line with that.[9]

Because of reported high rates of persistency/recurrency, the management of VUR in duplex systems remains controversial and, due to limited available literature, treatment protocols vary

widely between centres, leaving the choice of management to practitioners' personal preferences, rather than evidence-based data.[10,11]

Although endoscopic treatment has been widely accepted for single kidneys, its usefulness in duplex systems is not unanimously supported.

Some authors recommended a conservative approach based on close surveillance,[10,12] suggesting that a significant improvement or spontaneous resolution is expected in up to 72.7% of lower moiety ipsilateral VUR associated with ureterocoele.

Hunziker *et al*.[11] published the largest single-institution experience of endoscopic treatment of VUR complicating duplex kidneys and reported that the reflux was successfully treated in 68.4% of cases with one, in 25.7% with two and in 5.9% with three dextranomer/hyaluronic acid endoscopic subureteral injections.

Lee *et al*.[13] advocate a more invasive approach, consisting of common sheath reimplantation and ureterocelectomy, reporting success in decompressing the upper urinary tract in 92.3% of patients presenting high-grade VUR associated with ipsilateral ectopic ureterocoele in their cohort.

In literature, there is a huge discrepancy on reported outcomes[3,11,14,15] of primary minimally invasive approach (TUI or subureteral injection) ranging from 20% (Mariyappa *et al*.)[14] to 93.5% (Adorisio *et al*.).[12]

In our population, a primary endoscopic approach has been adopted chosen in 15/45 patients (33.3%) with ureterocoele and in 9/43 patients (20.9%) with VUR with a success rate of 53.3% and 55.6%, respectively.

We have noted, however, that a relatively small number of patients has undergone the endoscopic treatment in the presented cohort compared to published ones; this could be likely due to a switch in our attitude toward a more definitive surgery as primary approach. Support of this theory is provided by our analysis which showed that 2010 was the mode year for TUI and 2015 for more invasive surgeries such as heminephrectomy, nephrectomy and reimplantation.

A study published by Castagnetti *et al*.[16] advocates the same approach, demonstrating that upper pole partial nephrectomy is more effective than TUI in decompressing severely dilated urinary tracts and preventing UTIs (100% vs. 72%; $P = 0.2$), regardless of the presence of associated VUR, upper pole function or ectopic ureterocoele position.

Ectopic ureter

In case of duplex system associated with an isolated ectopic ureter, an upper pole heminephrectomy seems to be the most common approach for the treatment of dysplastic and poorly functioning moieties, whereas lower urinary tract reconstructive surgeries can be considered if renal scintigraphy shows a sufficient ipsilateral renal function.

In such cases, diversion of the upper into the lower moiety[17] or vesicoureteral reimplantation[18,19] could also be viable options.

As an alternative to more complex ablative or reconstructive techniques, laparoscopic ureteric clipping has also been described as a simple approach for the surgical management of symptomatic ectopic ureters or obstructive ureterocoeles associated with a poorly functioning or non-functioning upper moiety.[20,21] An increasing body of evidence describes this as a safe and quick procedure, less risky and with fast postoperative recovery compared to more invasive techniques.

We have not adopted this approach in our cohort, where most children with an ectopic ureter ($n = 19$; 86.4%) underwent a heminephrectomy; among those, five patients (26.3%) were approached laparoscopically with excellent results and no complications.

Ureteropelvic junction obstruction

UPJO in a duplex kidney is rare and its surgical treatment can be challenging.

Literature is scant regarding surgical management of such condition and the few published studies report good outcomes with heterogeneous managements comprising pyelopyelostomy, ureteropyelostomy, dismembered pyeloplasty and heminephrectomy.[22-24]

In our series, we observed only four patients with UPJO in a duplex kidney: Three of them underwent pyeloplasty and 1 a heminephrectomy.

The role of minimally invasive surgery in the management of duplex kidney

Loss of function of the remaining moiety is the most severe complication associated with a heminephrectomy and is reported in up to 5% of patients;[25] in our series, it was observed in only 2 children (3.1%) and, in both cases, it occurred after an open procedure.

Since the first description in 1993 by Jordan and Winslow,[26] laparoscopy has been demonstrated to be a safe and feasible approach for nephron-sparing heminephrectomy and it now represents our chosen technique in case of symptomatic non-functioning renal moieties.

A minimal invasive approach seems to offer, in this sense, a sensible advantage, as firstly demonstrated by Golebiewski *et al*.[27] and Garcìa-Aparicio *et al*.[28]

A review published in 2012 by Jayram *et al*.[25] investigated long-term outcomes and predictors of moiety deterioration in the largest series of retroperitoneoscopic heminephrectomies, which included 142 patients across 4 high-volume international teaching centres in the U.S. and Europe. Although no single risk factor was clearly identified, an impact on renal function was found to be linked with gas pressure on immature renal units, severely dilated upper moieties, excessive traction on the anchored vessels and immediate postoperative complications.

The small number of complications observed in our cohort does not allow us to comment on risk factors and impact on renal function. Furthermore, our preferred approach is transperitoneal. We believe that this approach has the advantage of a bigger field and better exposure of the hilum and provides better control during the dissection and an easier and more complete excision of the dilated ureter.

In the last decade, the robot-assisted laparoscopic (RAL) surgery has also been introduced and proved to be a viable alternative to traditional surgery to perform both upper and lower urinary tract surgery.[4,29-34]

Despite the technical advantage offered by the robotic over the laparoscopic approach, especially for complex reconstructive paediatric urological procedures such as ureteroureterostomy, it is still not widely adopted because of the considerable associated costs.

Ureteric suturing is made easier by using robotic devices thereby contributing to the excellent clinical outcomes of the RAL ureteroureterostomy reported in literature.

Even if ablative surgery (heminephrectomy) seems still the preferred option for the upper tract, especially in case of symptomatic patients and poorly functioning kidneys, the risk of ipsilateral moiety loss and the safety and efficacy recently demonstrated by the ureteroureterostomy make it an appealing alternative; the overall success rate of 100% reported in both series collected by Biles *et al*.[31] (12-patients) and Herz *et al*.[4] (14-patients) and the absence of intraoperative complication or open conversion support this claim.

Study limitations

This study suffers from some limitations. First, data were collected retrospectively. However, the possible bias related to missing or incomplete data are partially compensated by the large cohort and the systematic approach adopted in the analysis of the outcomes. Second, some more rare conditions, such as UPJO, were poorly represented in our cohort. Finally, data regarding the experience of surgeons and technical details were not uniformly reported and/or unreliable, therefore, they were not included in the analysis.

Conclusions

We have provided an overview of our 10-year experience, presenting the largest single-centre cohort of children with complicated duplex. Based on our data and on the available literature, the main dichotomy of the surgical approach lies in the choice between a less invasive (such as ureterocoele puncture or endoscopic treatment of the VUR) and a more invasive but definitive surgery (i.e., heminephrectomy, ureteric reimplantation) as primary approach. In this context, minimally invasive surgery has increasingly gained popularity and achieved excellent results and can be considered a gold standard for a more definitive surgical approach, either ablative or reconstructive.

Our analysis has also shown that children without antenatal diagnosis or with either an upper tract obstruction or VUR need to be looked after more closely since they are at greater risk of developing UTIs.

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Conflicts of interest

There are no conflicts of interest.

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