

A single center study of two types of upper kidney preservation surgery for complete duplicate kidney in children

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Research Article

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Abstract

Objective: To compare the efficacy, advantages and disadvantages of insertable ureteral reimplantation (UC group) and ureteral end-to-side anastomosis (UU group) in the treatment of duplicate kidney, and summarize the clinical experience in diagnosis and treatment.

Methods: Retrospective analysis was performed on 20 cases of duplicate kidney in our hospital from April 2016 to June 2021, including 11 cases of insertable ureteral reimplantation and 9 cases of end-to-side ureteral anastomosis. There were 8 boys, 12 girls, 12 left and 8 right. There were 3 cases of urinary tract infection and 9 cases of urinary incontinence, all of the rest were found by B ultrasound in physical examination. The median age was 33.5 months. Preoperative and postoperative renal pelvis separation, ureteral dilation, operation time and drainage tube indwelling time were compared.

Results: There was no significant difference in the degree of renal pelvis separation and ureter tortuosity before operation between the two groups ($P > 0.05$), and there was significant difference in the operative time between the two types of operation and in the duration of indwelling drainage tube ($P < 0.05$), there were significant differences in the degree of hydronephrosis and ureteral dilation before and after the two operations ($P < 0.05$), while there were no significant differences in the recovery of kidney and ureter after the two operations ($P > 0.05$).

Conclusion: The two methods have their own advantages and disadvantages, both can be used as the choice of renal sparing therapy for complete duplicate kidney, it is necessary to choose the appropriate method according to the situation of children and the surgical experience of the doctors. Double J tube placement is helpful for finding and avoiding to damage the duplicate ureter intraoperative, without increasing the difficulty of operation, and can prevent anastomosis or ureteral orifice stenosis.

Background

Duplex pelvis and ureter malformation is a common urinary malformation in children with an incidence of 0.8-1% (1). It can be divided into complete type and partial type. The clinical manifestations of complete type duplicate kidney malformation are more common than partial type duplicate kidney malformation, it can be complicated with terminal ureteral cyst, ectopia of ureteral opening, vesicoureteral reflux, renal dysplasia etc. Its clinical manifestations include recurrent urinary tract infections, urinary incontinence, abdominal pain, etc. (2). The clinical manifestations of duplex pelvis and ureter malformation often require surgical intervention. With the development of medical diagnosis and treatment technology, the treatment of duplex pelvis and ureter malformation is no longer a single surgical resection, but an individualized treatment based on disease conditions. This paper retrospectively analyzed the clinical data of patients who underwent insertable ureteral reimplantation (UC group) and ureteral end-to-side anastomosis (UU group) in our hospital, and conducted a single-center comparative study of the two renal preserving surgical methods to evaluate their efficacy, understood the effect of double J tube on operation and postoperative recovery of children.

Materials And Methods

Clinical data

A retrospective analysis was performed on 20 cases (from April 2016 to June 2021) of complete duplicate kidney with sparing upper kidney in our center, including 11 cases of insertable ureterovesical reimplantation (UC group) and 9 cases of end-to-side ureteral anastomosis (UU group).

There were 8 boys, 12 girls, 12 left and 8 right, 3 cases of urinary tract infection and 9 cases of urinary incontinence, the rest were found by B ultrasound in physical examination. The median age was 33.5 months.

All cases underwent urological b-ultrasound, MRU, urological CT, IVU and VCU examination preoperative. According to the excretion of contrast agent and morphology by urinary CT and IVU, it is possible to determine whether duplicate upper kidney has the preservation value. All cases were diagnosed as complete duplicate kidney, with hydronephrosis of the upper kidney and tortuosity of the upper ureter. One patient had ipsilateral vesicoureteral reflux of upper ureter (grade I), and 2 patients had ureteral terminal cyst of the upper ureter. All children with urinary tract infection received anti-infective treatment and underwent surgery after reviewing normal urine routine. Preoperative and postoperative renal pelvis separation, degree of upper ureteral dilation, operation time and drainage tube indwelling time were compared. See Table 1 and Table 2 for details.

Methods

The two groups of surgeons were in the same treatment team with skilled laparoscopic techniques.

UC group: After successful anesthesia, the children were placed in supine position with hip pads and routine disinfection towels, and catheterization was retained. A small incision was made at the lower margin of the umbilicus, and 5mm Trocar was inserted. A pneumoperitoneum tube was connected to establish a CO₂ pneumoperitoneum. 3mm trocar and 5mm trocar were inserted into the midline of the clavicle below the eyepiece. After standard instrument implantation, the peritoneum of the affected side was cut by ultrasonic knife, and the lower segment of the upper renal ureter of the affected side was exposed. Attention should be paid to not hurting the lower renal ureter of the affected side. The upper renal ureter was severed near the bladder (the distal suture with vesicoureteral reflux or set aside without vesicoureteral reflux), double J tube placement into the upper renal ureter, a bladder incision of approximately 0.8cm was made 2cm above the lower renal ureterovesical junction, and the whole bladder layer and ureteral plasma muscle layer were sutured and fixed with 4-0 absorbable line. No active bleeding was detected, a pelvic drainage tube was indwelled and fixed, the trocar was exited, the incisions were bonded with medical glue.

UU group: the lithotomy position was taken first, and the surgical field was routinely disinfected. Transurethral cystoscope was placed, and the duplicate upper ureteral ectopic orifice and lower renal ureteral orifice were seen. Double J tube was placed retrograde in the lower renal ureter of the affected side, cystoscope was withdrawn and catheterization was retained. After that, the children changed to supine position, the affected side of the waist and back pad high, and routine disinfection towel again.

A 5 mm Trocar channel was established through umbilical ring incision, and a CO₂ pneumoperitoneum was established by connecting the pneumoperitoneum tube. A 3 mm Trocar channel and a 5 mm Trocar channel were established lower than either side of the umbilical incision.

The lateral peritoneum at the pelvic iliac vessel of the affected side was cut by ultrasonic knife, and the tortuous upper renal ureter of the affected side was dissociated and exposed, and the ureter was severed near the bladder (the distal suture with vesicoureteral reflux or set aside without vesicoureteral reflux), the lower renal ureter was found through a double J tube. A longitudinal incision of about 1cm was made in the inner side of the lower ureter at the iliac vessel, the upper renal ureter was cut diagonally, and the upper-lower ureters(end to side)were sutured intermittently with 5-0 absorbable line. No active bleeding was detected, a pelvic drainage tube was indwelled and fixed, then withdrew the trocar, the incisions were cemented with medical glue.

Urinary tubes were removed about 10 days after surgery in both groups, and pelvic drainage tubes were removed according to drainage conditions (extubation indicated that drainage flow was less than 5mL/day).

Statistical methods

SPSS 23.0 was used for data collation and analysis. Independent sample T test was used to compare the operation time, the degree of upper renal pelvis separation (APRD) before and after surgery, the diameter of ureter, and the removal time of pelvic

drainage tube after surgery between the two groups. Continuous measurement data of operative age and follow-up time were represented by median. $P < 0.05$ was considered as statistically significant difference.

Results

Operations were successfully completed in both groups without conversion to laparotomy. All the children had their double J tubes removed one month after surgery, and no cases of febrile urinary tract infection, anastomotic obstruction, vesicoureteral reflux, residual ureteral syndrome or abdominal pain and discomfort occurred during the period. No recurrent cysts occurred in the 2 children with terminal ureteral cysts.

The median follow-up age of the 20 children was 13 months. The follow-up included the degree of upper renal pelvis classification, upper ureter diameter. There was no significant difference in APRD and ureter diameter between the two groups before surgery ($P=0.44$, $P=0.29$;

$P > 0.05$); there was significant difference in the operative time between the two methods ($P=0.04$, $P < 0.05$), and the operative time was faster in the UC group. There were significant statistical differences in APRD and ureteral recovery before and after operation in UC group ($P=0.02$, $P=0.001$; $P < 0.05$), and the same in UU group ($P=0.001$, $P=0.0004$; $P < 0.05$); there was no significant difference in postoperative APRD and ureter diameter between the two groups ($P=0.19$, $P=0.07$; $P > 0.05$); the duration of indwelling pelvic drainage tube was different ($P=0.02$, $P < 0.05$), and the duration of indwelling drainage tube was shorter in the UU group.

Discussion

Duplicate renal and ureter malformation is usually found due to clinical manifestations such as urinary tract infection, urinary incontinence or abdominal pain ect..Clinical treatment methods for complete duplicate kidney and ureter malformation are varied (3), there are two main treatment concepts of duplicate kidney: resection and preservation.

For functional upper kidneys, renal-sparing therapy is advocated. End-to-side ureteral anastomosis and ureterovesical replantation are two surgical methods to preserve the functional upper kidney. Lopes and Hosseini (4, 5) performed ureteral ligation or trophotropic vascular ligation of the upper kidney for the dysplasia or non-functional upper kidney without upper kidney resection, so as to reduce surgical trauma and make the upper kidney atrophy. However, the long-term therapeutic effect is debatable and lacks confirmation of large sample size. Resection of the upper kidney and ureter is the mainstay of treatment for nonfunctioning or dysplastic upper kidneys. Yin et al. (6) found that the proportion of postoperative complications and reoperation was higher for children with upper renal function $< 10\%$ who underwent upper renal sparing surgery compared with those who did not.

Renal nuclide examination can be used to determine the upper and lower semi-renal function of repeated kidney, so as to decide whether to perform renal preservation therapy. Our center cannot perform this examination because we do not have nuclear medicine department yet. Based on CT and IVU examination, we observed the thickness of the renal cortex of the upper kidney and the secretion of contrast media to evaluate whether there is any retention value (7). In this study, preoperative imaging examination showed that all the children had the value of preserving upper kidney. There was a statistical difference in the time of the pelvic drainage tube between the two groups. We considered that in the UC group, due to the opening of the bladder and its voluntary contractions, urine leakage may occur at the early stage of anastomosis, resulting in peritoneal inflammation and the increase of exudate.

Ureteral end-to-side anastomosis (UU method) and insertable ureterovesical reimplantation (UC method) are the two main methods of duplicate kidney preservation therapy. Villanueva et al. (8) thought that UU method did not need to open the bladder, and the trauma was smaller than insertable ureterovesical reimplantation method, they compared DaVinci Xi robot and open surgery in the treatment of children with complete duplicate kidney with UU method, found that the postoperative effect and safety were the same, the children recovered quickly and were easier for parents to accept who took DaVinci Xi

robot surgery. In our country, DaVinci Xi robot is not yet popular, and the cost is high, laparoscopic surgery is still the mainstream. Laparoscopic UU has already been used for the treatment of complete renal duplication (9). Chandrasekharam et al. (10) proposed that ureteral- ureteral reflux (yo-yo reflux) may occur in UU anastomosis, which is more likely to occur in higher location anastomosis of the ureters than in lower anastomosis of the lower ureters, which is likely to lead to the kidney infection and renal scar formation. Gerwin et al. (11) thought that Yo-Yo reflux was only a theoretical inference, which was not proved. Even if yo-yo reflux occurred, due to peristaltic transport of the ureter, reflux would only exist at the local anastomosis, not necessarily reach the renal pelvis, and would not cause repeated kidney infection and renal scar formation. There is no unified requirement for the diameter of the upper kidney ureter and the incision size of the lower kidney during the end-to-side anastomosis, and there are also controversies, it is generally believed that the ureter diameter > 2cm is not recommended to be treated with UU method, and the incision size of the lower kidney ureter is generally recommended to be about 1cm, otherwise it is easy to cause dysperistalsis of the lower ureter and finally lead to hydronephrosis or other complications(12,13).

Abdelhalim et al (14) reported to use UU method in the treatment of duplicate renal and ureter malformation children with non-functioning upper kidney or upper ureter diameter \geq 2cm, they had good results, all the children recovered well postoperation.

We realize that the longitudinal incision of the lower renal ureter and end-to-side anastomosis of the ureters during laparoscopic UU operation is the difficulty of the operation. During the operation, the upper renal ureter should be anastomosed with the lower renal ureter in an oblique plane, when the lower renal ureter is incised longitudinally, the head or tail of the intended incision position can be suspended from the lateral abdominal wall with an absorbable thread, which could reduce the mobility of the ureter and facilitates the cutting operation. For the upper renal ureter with a diameter of about 1.5cm, we directly performed end-to-side anastomosis, there was no febrile urinary tract infection and ureteral stump syndrome after operation, the children recovered well, we have no experience for the upper renal ureter with a diameter greater than 1.5 cm, and we recommend to perform UU method after trimming the upper renal ureter or insertable ureterovesical reimplantation. Compared with the two methods, there was a statistical difference in surgical time. UC method took shorter time, and the laparoscopic insertable ureterovesical reimplantation (UC method) in our center was simpler than that of UU method. UC method is prone to bladder spasm or leakage, and may appear anastomotic stenosis or reflux may occur (15). No cases of vesicoureteral reflux or ureteral opening stenosis were found after UC method. Tang et al. (16) proposed that insertable ureterovesical reimplantation after nipple formation at the distal ureteral opening would reduce the probability of ureteral reflux and anastomotic stenosis, but the laparoscopy technique required for the operation was relatively high. The patients studied in our center did not receive papillary ureterovesical replantation, so its efficacy could not be evaluated. When we with UC method for laparoscopic surgery, it should be noted that the opening of the bladder should be close to the ipsilateral junction of the lower renal ureter and bladder. Female children's upper kidney ureters must still be anastomosed with the bladder through the fallopian tube, as per the physiological and anatomical structure, otherwise hydronephrosis would develop during pregnancy. Both procedures must prevent the emergence of ureteral stump syndrome, hence the distal ureteral stump should be ligated in children with reflux.

Depending on the surgeon's preferences, the double J tube is placed differently in the two surgical approaches. During the procedure, the UC group was normally implanted under the laparoscope, but the UU group was usually placed retrogradely with the cystoscope first. Both double J tubes can also be implanted retrogradely prior to surgery. The two types of double J tubes are inserted into the lower renal ureter before the laparoscopic procedure to guide the procedure and protect the lower renal ureter. If UC surgery is performed in the upper renal ureter in a retrograde manner, the upper renal ureter together with the double J tube, can be placed into the bladder. There is a slight chance of misplacement with repeated retrograde ureteral catheterization under cystoscopy. The caudal double J catheter can be transferred via the lower renal ureter to the bladder by the end-to-side ureteral anastomosis during surgery if the UU surgery misplaces the double J catheter into the upper renal ureter. However, the double J tube in the lower renal ureter can be removed by cystoscope at the end of the UC operation. Indwelling double J tube in UC can prevent possible the end-to-side ureteral anastomosis and ureteral new orifice stenosis in the bladder after surgery. Combined with our surgical experience, the double J tube in the UU operation is located in the lower renal ureter or the cross is located in the upper and lower ureters, or the double J tube indwelling in the UC operation does not

increase the difficulty of the operation and does not affect the postoperative of the children's recovery. Because double J tube has no anti-reflux effect, when the pressure in the bladder increases, it will cause urine to reflux to the renal pelvis and increase the risk of urinary tract infection. Our center recommends that for children with indwelling double J tube with normal urine routine, take 1/3 – 1/4 of the therapeutic dose of cephalosporin antibiotics before sleep.

Conclusions

In conclusion, the two surgical methods have their own advantages and disadvantages. For those with experienced laparoscope operation, end-to-end anastomosis can be performed after pruning, or insertive ureterovesical reimplantation can be performed after forming the ureteral papillae, in order to reduce the incidence of vesicoureteral reflux and ureteral orifice stricture. The placement of double J tube is helpful for finding ureter during surgery, without increasing the difficulty of operation, and can prevent anastomosis (UU surgery) or ureteral new opening stenosis (UC surgery) postoperative. In clinical treatment, it is necessary to choose appropriate treatment methods according to the situation of children and the doctor's operative experience. The results of the study in our center have certain limitations.: the number of cases in the study is less, and the recovery of renal function cannot be quantified without nephrogram examination. The long-term follow-up results still need to be followed up.

Declarations

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions:

Conceived and designed the study: Han Chu and Zhang Xiansheng; Eligible study collection, quality assessment and data extraction: Han Chu, Qi-Fei Deng ; Statistical analyses, preparation of tables and figures: Han Chu and Yong-Sheng Cao. Wrote and revised the manuscript: Han Chu ; All authors reviewed the final manuscript.

Ethics approval

This is an observational study. The Anhui Children's Hospital Research Ethics Committee has confirmed that no ethical approval is required.

Consent to participate

Not applicable.

Consent to publication

Not applicable.

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Tables

Table 1

UC group

Age(month)	gender	Preoperative APRD (cm)	Preoperative diameter of upper kidney ureter (cm)	operation time(min)	Postoperative APRD (cm)	Postoperative diameter of upper kidney ureter[cm]	Indwelling pelvic drainage tube (day)
Patient1 25	girl	2.5	1.5	222	2.3	0.4	10
Patient2 60	girl	2.6	2.1	220	1.3	0.5	5
Patient3 ¹ 36	girl	1	1.2	184	0	0.8	7
Patient4 2	boy	1.4	1.2	224	1	0.5	6
Patient5 31	girl	2	2	240	1	1.1	22
Patient6 36	girl	1.6	1.6	318	1	0.7	13
Patient7 4	boy	1	1.3	169	0.9	0.6	10
Patient8 120	girl	0.7	1.7	233	0.4	0.7	6
Patient9 ² 96	boy	4	1.7	220	2.8	0.9	4
Patient10 6	boy	1.9	1.4	330	1	1	10
Patient11 7	boy	1.8	1.6	190	0.5	0.8	10

¹with vesicoureteral reflux;²with ectopic ureterocele.

Table 2

UU group

Age[month]	gender	Preoperative APRD (cm)	Preoperative diameter of upper kidney ureter (cm)	operation time(min)	Postoperative APRD (cm)	Postoperative diameter of upper kidney ureter[cm]	Indwelling pelvic drainage tube (day)
Patient1 36	girl	1.5	2	283	1	1	5
Patient2 84	girl	0.6	0.7	125	0	0.5	11
Patient3 ¹ 13	girl	3.7	1	257	2	0.7	6
Patient4 16	girl	1.8	2.3	133	1	1	6
Patient5 36	boy	2.5	1.7	148	1.6	0.8	5
Patient6 36	girl	1	1.1	115	1	0.7	6
Patient7 15	boy	2.4	1.4	218	1.5	1	6
Patient8 5	boy	1.7	1.5	132	1	1.2	3
Patient9 60	girl	1	1.5	173	0	1	4

¹with ectopic ureterocele.