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Outcome analysis of early surgery and conservative treatment in neonates and infants with severe hydronephrosis

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Abstract

Objective: The treatment strategy and timing of ureteropelvic junction obstruction (UPJO) in infants remain controversial. This study aimed to compare the effect of early surgical treatment (EST) and conservative treatment (CT) on neonates and infants with UPJO and their recovery of renal function and morphology.

Methods: Eighty neonates and infants with severe hydronephrosis were enrolled in this study. They received early pyeloureteroplasty or CT. Diethylenetriamine pentaacetate was used to assess renal function.

Results: There were no significant differences in renal function or renal indices at baseline between the two groups. At 3 and 6 months of follow-up, the anteroposterior diameter of the renal pelvis and the Society of Fetal Urology grade in the EST surgery group were significantly lower compared with those at baseline. The thickness of the renal cortex was greater in the EST group than in the CT group at 3 and 6 months of follow-up. After follow-up for 6 months, renal function in the EST group was significantly better than that in the CT group.

Conclusion: EST accelerates the recovery of renal morphological and functional indices in neonates and infants with severe hydronephrosis.

Keywords

Hydronephrosis, pyeloureteroplasty, conservative treatment, renal function, ureteropelvic junction obstruction, infant

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Introduction

Ureteropelvic junction obstruction (UPJO) accounts for one of the most important causes of neonatal hydronephrosis,[1] and its incidence ranges from 1/600 to 1/800.[2] At present, the diagnostic rate of congenital hydronephrosis increases yearly because of the extensive application of prenatal ultrasound.[3] In children, UPJO is mostly caused by congenital dysplasia of the ureteral muscle layer and stenosis of the ureteral junction. Typically, obstructive nephropathy is the primary cause of renal failure in infants.[4,5] Therefore, how to effectively treat UPJO-induced severe hydronephrosis in infants has become a major concern in experts in China and other countries.

There are several treatment options for prenatal hydronephrosis in infants, but all of them are controversial. Among them, the most radical approach is to perform prenatal surgery to maximally eliminate urinary problems before renal function is damaged. However, prenatal B-ultrasound cannot distinguish whether hydronephrosis is caused by obstruction or due to other reasons, and prenatal surgery is less practical because it may harm the fetus and the mother.[6] The majority of children with prenatal hydronephrosis receive conservative treatment (CT) or early surgical treatment (EST) after birth. Biopsies in the early stage of obstruction are characterized by inflammatory cell infiltration and enlargement of the renal tubule lumen, and over time, renal failure occurs.[7]

Previous studies have shown that surgical intervention should be conducted as early as possible after severe hydronephrosis occurs in the kidney.[8,9] However, Vemulakonda et al. found different results to these previous studies. In their study, children with UPJO-induced hydronephrosis were treated with surgery within 1 year old and the hospitalized children were followed up in the long term. In these patients, the incidence of postoperative re-obstruction and the risk of re-hospitalization were higher than those in patients who received surgery at older than 1 year old.[10] Zhang et al. showed that the degree of hydronephrosis was not aggravated in a long-term follow-up, and the thickness of the renal parenchyma was not significantly changed.[11] Therefore, these authors considered that fetal hydronephrosis should not be treated immediately after delivery, and it must be closely followed up until surgery instead.

There is no gold standard of timing for the surgical treatment of UPJO-induced severe hydronephrosis in infants. Therefore, this prospective cohort study aimed to compare the changes in renal function and morphology between neonatal patients receiving EST and those undergoing CT for severe hydronephrosis. The findings in this study might provide clinical guidance for the treatment of UPJO.

Materials and methods

The reporting of this study conforms to the STROBE guidelines.[12] Ethical approval was obtained from the Medical Ethics Committee of Anhui Provincial Children's Hospital. All patients participating in the study provided written consent. Clinical data were collected from neonates and infants with severe hydronephrosis who were admitted to our department from January 2019 to August 2020. All cases of prenatal hydronephrosis were diagnosed by prenatal B-ultrasound. Prenatal hydronephrosis with an anteroposterior diameter (APD) $\geq$4 mm in the second trimester or 7 mm in the third trimester was detected by ultrasound at a local hospital. The inclusion criteria were as follows: (1) the age of children was $<$2 months; (2) there were no obvious clinical symptoms; (3) UPJO-induced severe hydronephrosis was found by intravenous pyelography, and the

separation of the renal pelvis was $\geq$3 cm at the time of treatment; and (4) a Society of Fetal Urology (SFU) grade of 4. Children with bilateral hydronephrosis, obvious clinical symptoms, or other urinary malformations were excluded from this study. Before grouping, the parents were informed of the advantages and disadvantages of the two choices of treatment. Depending on the patient's actual condition, the decisions on whether EST or CT should be performed was made together with the parents.

In the EST group, all children received standard Anderson–Hynes cut-off pyeloureteroplasty, and all surgeries were performed by experienced chief surgeons at our department. A surgical incision was made using an extraperitoneal approach in the middle and upper abdomen to locate the dilated ureteropelvic junction. Thereafter, a 5-0 absorbable suture was used, and a ureteral stent and drainage tubes were inserted. At 4 weeks after surgery, the ureteral stent was removed. Diethylenetriamine pentaacetate (DTPA) was used to assessed renal function, and ultrasound examinations were performed at 3 and 6 months after surgery. Ultrasound examinations were completed by the same sonographer to minimize errors.

In the CT group, all children were reexamined in the outpatient clinic once a month after the initial evaluation. The progression of the children's condition was recorded and routine urine examinations were performed to rule out the possibility of urinary tract infections. Moreover, ultrasound examinations and renal function as assessed by DTPA were performed at 3 and 6 months. During the follow-up period, children whose renal function decreased by 10% or those with apparent clinical symptoms (abdominal pain, vomiting, or abdominal mass) were transferred from the follow-up group to the surgical treatment group.

The data were processed using IBM SPSS statistical software version 20 (IBM Corp., Armonk, NY, USA). The results are expressed as mean $\pm$ standard deviation. The chi-square test and the t-test were adopted to compare measurement and count data, respectively. $P < 0.05$ indicates a statistically significant difference.

Results

Ninety-six neonates and infants were included (Figure 1). Among them, 16 were excluded owing to clinical symptoms (n = 7), bilateral symptoms (n = 5), or an abnormal urinary tract structure (n = 4). The remaining 80 neonates and infants were divided into the EST group (n = 40) and the CT group (n = 40).

The general characteristics of these 80 children are shown in Table 1. The mean age of children in the EST group was 44.73 ± 15.55 days and that of children in the CT group was 50.00 ± 15.98 days. A total of 75% of the children were boys, and 56.25% of hydronephrosis occurred in the left lateral position. There were no significant differences in the general characteristics of the neonates and infants between the two groups. There was also no significant difference in the APD of the renal pelvis or renal function between the two groups at baseline (Table 1).

During follow-up in the CT group, three children showed persistently decreasing renal function by >10% as shown by two consecutive reexaminations. Five children had a fever with a body temperature of >38.5°C, recurrent urinary tract infections, and a positive urine culture ($\geq$100,000 cfu/mL), and they underwent pyeloureteroplasty. All patients in the EST group recovered well after surgery.

The APD of the renal pelvis and SFU grades were improved during the 3- and 6-month follow-up periods in both groups (Table 2). In the EST group, the APD of

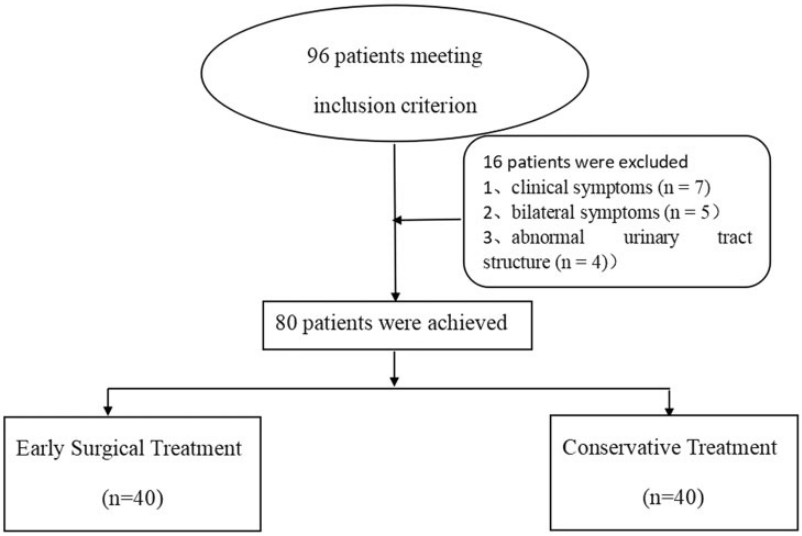

Figure 1. Flowchart of patient selection.

Table 1. Initial characteristics of hydronephrosis in neonates and infants.

Variable	EST	CT	P
Age (days)	44.73 ± 15.55	50.00 ± 15.98	0.139
Sex			0.439
Male	28 (70)	32 (80)	
Female	12 (30)	8 (20)	
Side			0.652
Left	21 (52.5)	24 (60)	
Right	19 (47.5)	16 (40)	
APD of the renal pelvis (cm)	3.67 ± 0.64	3.48 ± 0.62	0.189
Length of the kidney	9.03 ± 1.79	8.57 ± 0.91	0.156
Width of the kidney	4.93 ± 1.15	4.65 ± 1.05	0.206
SFU	4	4	
Renal cortex thickness (cm)	0.25 ± 0.68	0.24 ± 0.05	0.302
DRF%	34.55 ± 11.44	36.83 ± 4.39	0.245

Values are mean ± standard deviation or n (%).
EST, early surgical treatment; CT, conservative treatment; APD, anteroposterior diameter; SFU, Society of Fetal Urology; DRF, differential renal function.

the renal pelvis and renal cortex thickness were significantly improved compared with those before surgery (both $P < 0.05$) (Figure 2). More significant changes in the APD of the renal pelvis and the SFU grade were observed in the EST group than in the CT group (both $P < 0.05$) (Table 2).

The renal cortex thickness in both groups increased to varying degrees at 3 and 6 months of follow-up. The EST group achieved a faster recovery of renal function and a greater thickness of the renal cortex compared with those in the CT group at 3 and 6 months (both

Table 2. Follow-up characteristics of hydronephrosis in neonates and infants.

Variable	Follow-up (months)	EST	CT	P
APD (cm)	3	1.86 ± 0.89	2.62 ± 0.82	0.001
	6	1.07 ± 0.47	1.94 ± 1.19	0.001
Length of the kidney	3	7.77 ± 1.32	7.92 ± 0.92	0.559
	6	7.39 ± 0.85	7.52 ± 1.24	0.598
Width of the kidney	3	4.11 ± 1.04	3.96 ± 0.86	0.487
	6	3.67 ± 0.63	3.56 ± 0.86	0.538
SFU	3	2.38 ± 0.59	3.73 ± 0.55	0.01
	6	2.02 ± 0.57	2.88 ± 0.86	0.001
Renal cortex thickness (cm)	3	0.34 ± 0.78	0.30 ± 0.05	0.002
	6	0.40 ± 0.08	0.32 ± 0.07	0.0001
DRF%	3	41.25 ± 8.78	41.65 ± 4.86	0.804
	6	47.20 ± 7.33	43.26 ± 5.87	0.021

Values are mean ± standard deviation.
EST, early surgical treatment; CT, conservative treatment; APD, anteroposterior diameter; SFU, Society of Fetal Urology; DRF, differential renal function.

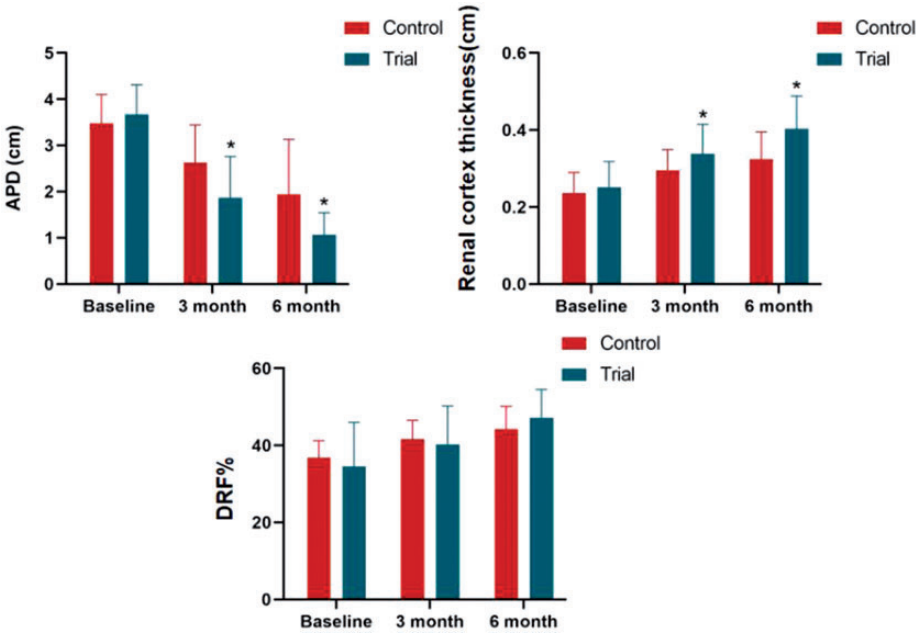

Figure 2. Comparison of the APD of the renal pelvis, renal cortex thickness, and DRF% in the two groups at follow-up and baseline. *P < 0.05 versus baseline.
Control, early surgical treatment; trial, conservative treatment; APD, anteroposterior diameter; DRF, differential renal function.

$P < 0.05$, Table 2). The renal cortex thickness also significantly improved from 3 months to 6 months in the CT group ($P < 0.05$).

At the 3-month follow-up, renal function was improved in both groups, but there was no significant difference between the groups. At 6 months, renal function in both groups was further improved, and renal function was more significantly improved in the EST group than in the CST group ($P = 0.021$, Table 2). In neonates and infants in the CT group, their renal function appeared to improve after treatment, but there was no significant difference compared with baseline.

During the follow-up period, no apparent change in the size of the kidney was observed.

Discussion

The management of UPJO in infants is complicated and challenging. Furthermore, distinguishing suitable candidates for immediate surgery or conservative observation is difficult. Some infants with UPJO may have spontaneous remission, while timely surgical treatment may cause complications and adverse consequences. Infants who receive CT may also be associated with the risk of failure in renal functional recovery. Therefore, a customized treatment protocol is likely to be the optimal treatment strategy.[13]

The present study evaluated the degree of UPJO on the basis of renal function assessed by DTPA to observe the changes in the ureteropelvic junction after EST or CT. We found that, in neonates and infants with severe hydronephrosis, their renal anatomical morphology and function might have deteriorated during follow-up in CT. EST is recommended in the presence of an apparently declined renal function, clinical symptoms, or recurrent urinary tract infections. None of these problems were found in the EST group. Pyeloureteroplasty, which is a classic surgical treatment that has been applied in clinical treatment for many years, effectively prevents the deterioration of renal function and improves renal function.

Ransley and colleagues initiated a personalized protocol of hydronephrosis treatment, and proposed APD indicators as important factors in predicting the surgical treatment of hydronephrosis.[14] Subsequently, with the emergence of renal function assessment by DTPA, renal function can be detected independently, and the indication for surgical treatment is becoming increasingly clear.[15] A previous study showed that approximately 75% of infants with hydronephrosis were safe after long-term conservative follow-up.[16] Therefore, conservative follow-up observation is currently adopted for infants with prenatal hydronephrosis. Proponents of this perspective expect that treatment can reduce unnecessary surgery. Further deterioration of renal function can be treated by surgical intervention, even if hydronephrosis in infants is aggravated.[17]

Some scholars prefer CT for all cases of prenatally diagnosed hydronephrosis, while others hold the opposite opinion. Several clinical research teams have shown that conservative treatment against hydronephrosis may lead to deterioration of renal function in some cases, and renal function in these cases cannot be fully recovered, even after surgical treatment.[18–21] Liu et al. studied infants who received surgery or CT, and they were followed up for 6 and 12 months.[22] They found that the SFU grade in infants in the surgery group was markedly lower than that in the CT group, which is consistent with our study. Additionally, Chertin et al. reported that 50% of infants with prenatal hydronephrosis underwent surgery within 2 years old, while the remaining infants received surgery within the subsequent 2 years.[23]

Arora et al. showed that EST facilitated the recovery of renal function in patients with severe hydronephrosis, whereas delayed surgery only restored part of the lost renal function.[24] Therefore, surgical methods are the preferred choice for the treatment of severe hydronephrosis.

Our study indicated that changes in renal function were related to the treatment mode. When neonates and infants treated with EST were followed up for 6 months, renal indices and renal function were improved. These variables in children in the CT group were improved to some extent, but renal functional recovery was slower than that in the EST group. Five children in the CT group received delayed pyeloureteroplasty when they were followed up for 6 months. When these five children who received EST were excluded, the renal indices in the CT group were also improved to some extent, but it was not as marked as that in the EST group.

Limitations to this study are its small sample size and patients were not randomly selected. The present study aimed to describe the authors' experience in the treatment of severe hydronephrosis in neonates and infants. The mode of treatment was agreed by the parents and the physicians through communications, and it was not completely random. However, we believe that our research still has value for the management of prenatal hydronephrosis.

Conclusions

In the diagnosis and treatment of neonates and infants with severe hydronephrosis, EST can facilitate the recovery of renal structure and renal function, whereas CT should take into account the deterioration of renal function. The decision on the diagnosis and treatment of neonates and infants with severe UPJO should be made through repeated communications between physicians and parents by carefully weighing the advantages and disadvantages of these two methods.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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