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Clinical Features And Management Of Neonatal Hydronephrosis Detected By Ultrasonographic Neonatal Screening: A Single-Center Study

Masaki Horiike[1,2]*, Satoshi Yokoyama[4], Tatsuo Nakaoka[3] and Akira Yoshida[3]

[1]Department of Pediatric Surgery, Hyogo Prefectural Kobe Children's Hospital Japan
[2]Department of Pediatric Surgery, Japanese Red Cross Society Wakayama Medical Center Japan
[3]Department of Pediatric Surgery, Osaka City University, Graduate School of Medicine Japan
[4]Department of Pediatric Surgery, Japanese Red Cross Society Wakayama Medical Center Japan

Abstract

Objective: To clarify the clinical course and appropriate management of undetectable neonatal hydronephrosis during the fetal period.

Study design: We included neonates born in the obstetrics department of our hospital between November 2018 and September 2020. Their urinary system was examined by abdominal ultrasonography. The Society for Fetal Urology (SFU) classification and anterior-posterior renal pelvic diameter (APRPD) were used as parameters to assess urinary tract dilatation. The number of participants, left-right difference in hydronephrosis, male-to-female ratio, incidence of urinary tract infections (UTIs), vesicoureteral reflux (VUR), number of detections, and time course of SFU grade and APRPD were examined.

Results: Totally, 244 patients (146 male, 98 female, 317 kidneys) were examined in this study. The left kidneys of 136 patients and the right kidneys of 35 patients, and bilateral kidneys of 73 patients were examined. UTIs were observed in four cases (1.6%) during follow-up. Patients with UTIs underwent voiding cystourethrography, and VUR was found in two cases. The most frequently detected SFU grade at birth was grade 1 (99.3%), and only two kidneys had SFU grade 2. A total of 171 (54%) patients showed improved hydronephrosis at the age of one month. In addition, 307 kidneys (96.8%) showed improved hydronephrosis at 24 months of age.

Conclusion: Most mild prenatal hydronephroses resolve spontaneously. However, hydronephrosis worsens over time in some cases. Cases with APRPD within the interquartile range are considered to have a good prognosis, whereas hydronephrosis exceeding the quartile should be carefully followed.

Keywords: Neonatal Hydronephrosis; Clinical features; Management; Ultrasonographic screening

Abbreviations and Acronyms

SFU: The society for Fetal Urology

APRPD: Anterior posterior renal pelvic diameter

UTI: Urinary tract infection

VUR: Vesicoureteral reflux

AHN: Antenatal hydronephrosis

PHN: Postnatal hydronephrosis

mAPD: Median anterior posterior renal pelvic diameter

UPJO: Ureteropelvic junction obstruction

Introduction

Hydronephrosis is defined as the dilatation of one or more components of the renal collecting system. Antenatal hydronephrosis (AHN) is detected in 1–5% of pregnancies during antenatal ultrasound screening, [1-4] and postnatal evaluation of neonates begins with compulsory urinary tract ultrasound investigation. However, hydronephrosis in neonates may remain undetected on antenatal ultrasonography during the second or third trimester of pregnancy. It is common to accidentally detect non-AHN hydronephrosis on neonatal abdominal ultrasonography in real-world practice; however, the clinical features of such neonates are unknown, and appropriate management is unclear. Therefore, dealing with such cases is often difficult. We aimed to regularly examine all neonates born at our facility for hydronephrosis using abdominal ultrasonography and to clarify the clinical course and appropriate management for the condition from the neonatal period to late infancy. Herein, we also considered the differences in the detection rate of hydronephrosis, the sex ratio, and the clinical course between undetected neonatal hydronephrosis during fetal period and detected hydronephrosis after birth, thereby retrospectively detecting AHN. We hypothesized that non-AHN hydronephrosis in neonates is a pathological condition that becomes apparent from the perinatal and neonatal periods and is a transient obstruction due to functional immaturity at the ureteropelvic junction, and that the obstruction improves over time after birth, and that the detection rate is much higher than that of AHN.

Patients and Methods

We included neonates whose hydronephrosis was detected only after birth and had no other abnormalities. Thus, we defined hydronephrosis as an isolated postnatal hydronephrosis (PHN).

***Corresponding author:** Masaki Horiike, Department of Pediatric Surgery, Hyogo Prefectural Kobe Children's Hospital, 1-6-7 Minatojima Minami-machi, Chuo-ku, Kobe, Hyogo, 650-0047, Japan, Tel: +81-78-945 7300, Fax: +81-78-302 1023; E-mail: masakihoriike1031@gmail.com

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Participants were neonates born in the obstetrics department of our hospital between November 2018 and September 2020. After obtaining institutional review board approval, we retrospectively reviewed the ultrasonographic findings and progress of the participants. All patients underwent fetal ultrasonography screening for various organs at 28–30 weeks of gestation. Patients unable to undergo follow-up after birth due to home birth or absenteeism, or patients with unclear prenatal diagnosis of hydronephrosis were excluded. The urinary system of the neonates was examined using abdominal ultrasonography for 28 days after birth. Patients with unstable respiratory and circulatory dynamics at birth were prioritized for treatment, and ultrasonographic screening was performed only after stabilization.Prior to screening, participants were well-hydrated in the neonatal room and under general care. Hydration was confirmed by checking sufficient bladder urine volume. Screening ultrasonography was performed on a flat table in the neonatal room to maintain a supine position on the table to facilitate an accurate diagnosis.Screening ultrasonography was performed using a Xario 200 (Canon Medical Systems, Tochigi, Japan) with a resolution of 0.2–1.0 mm, making detailed scanning possible. The sonographer had more than 10 years of experience with abdominal ultrasonography in newborns and children. The Society for Fetal Urology (SFU) classification was used as a semi-quantitative parameter for urinary tract (UT) dilatation, and the anterior-posterior renal pelvic diameter (APRPD), which is currently the most widely accepted parameter for defining a sonographically evident renal pelvis, [5] was used as the quantitative parameter. In this study, we examined the following items for PHN and AHN as a reference:

1) number of participants and total number of affected kidneys

2) left-right differences in hydronephrosis

3) male-female ratio

4) incidence of urinary tract infections (UTIs) that occurred during the observation period

5) number of vesicoureteral reflux (VUR) detections, and

6) time course of SFU grade and APRPD. JMP® (version 14.0; SAS Institute Japan, Tokyo, Japan) was used for the statistical analysis. Continuous data with a normal distribution are described using median and interquartile range. Comparison of the APRPD between PHN and AHN at birth and at 1, 6, and 12–24 months of age was performed using the t-test. Statistical significance was set at $P < 0.05$ (Table 1).

Table 1 : Patient characteristics of PHN and AHN in this study.

Characteristics	Frequency n(%)	
Total number of patients	1251	
PHN		
Number of patients	244	(19.5)
Total number of renal units	317	
Left renal units	136	
Right renal units	35	
Bilateral renal units	73	
Sex		
Male	146	
Female	98	
Urinary tract infection(UTI)	4	(1.6)
Male	2	
Female	2	
VUR	2	(0.8)
AHN		
Number of patients	9	(0.7)
Total number of renal units	14	
Left renal units	4	
Right renal units	0	
Bilateral renal units	5	
Gender		
Male	9	
Female	0	
Urinary tract infection(UTI)	0	
VUR	0	

Results

Patient characteristics

The total number of births in our obstetrics department during the study period was 1,271, of which 264 were found to have PHNs. Twenty patients were excluded from this study, including 10 home births, 9 absentees who were unavailable at the time of the study, and 1 unclear prenatal diagnosis of hydronephrosis. Thus, of the 1251 included patients, the total number of PHN patients was 244 and the total number of AHN patients was 9.Among the 244 AHN patients, 317 kidneys were assessed (136 left kidneys, 35 right kidneys, and 73 bilateral). Overall, 146 and 98 patients were male and female, respectively. UTIs were observed in four patients (1.6%) during follow-up. Voiding cystourethrography (VCUG) was performed in patients with UTI, and VUR was observed in two patients. Nine male patients with AHN were included. Fourteen kidneys were studied in these patients (four left, five bilateral). None of the right kidneys were included in this group. UTI incidence was not observed in AHN cases.

Time course of SFU grade and APRPD

The SFU grade and median APRPD (mAPD) for each grade of PHN are summarized for each observation period at birth, 1 month after birth, 6 months after birth, 12 months after birth, and 24 months after birth (Table 2).

The most frequently detected SFU grade of PHN at birth was grade 1 (99.3%), and only two kidneys had an SFU grade of 2. Of the 317 kidneys with PHN detected at birth, 171 (54%) showed improved hydronephrosis at 1 month of age, while 307 kidneys (96.8%) showed improved hydronephrosis at 24 months of age.

PHN included kidneys in which the SFU grade increased from 1 to 2 at 1 month after birth, and subsequently improved. There were no kidneys in which the SFU grade had progressed to ≥ 3.

In contrast, AHN included eight kidneys (67%) with SFU grades 1 and four (37%) with SFU grade 2. At 6 months of age, six kidneys (50%) with hydronephrosis had improved, and at 24 months, ten kidneys (83%) had improved. Hydronephrosis progressed to grade 3 in one kidney during the observation period.

The mAPD tended to increase as the observation period progressed in PHN. In AHN cases, mAPD tended to increase and then decrease during the observation period. Although the mAPD at birth was

Table 2: Summary of SFU grade and median APRPD for each grade and observation period of PHN and AHN.

	at birth		1 month		6 months		12 months		24 months	
	n	mAPD	n	mAPD	n	mAPD	n	mAPD	n	mAPD
SFU grade										
0	0	–	171	–	69	–	38	–	29	–
1	315	2.2(2.1-3.1)	122	3.2(2.6-4.2)	60	3.2(2.5-4.0)	32	3.7(2.8-5.4)	9	4.8(3.9-5.6)
2	2	4.7(4.5-4.9)	24	5.0(4.3-6.2)	17	7.8(4.4-8.4)	7	7.5(5.4.7-8.6)	1	4.1
3	0	–	0	–	0	–	0	–	0	–
4	0	–	0	–	0	–	0	–	0	–
	n	mAPD	n	mAPD	n	mAPD	n	mAPD	n	mAPD
SFU grade										
0	0	–	2	–	2	–	2	–	4	–
1	8	3.0(2.8-3.7)	5	3.2(3.1-4.2)	5	3.8(2.2-4.0)	3	2.2(2.1-6.6)	0	–
2	4	6.7(4.9-9.7)	4	7.2(6.5-8.4)	3	9.2(6.3-20)	3	7.8(7.8-10.9)	2	8.3(8.2-8.4)
3	0	–	1	25	0	–	0	–	0	–
4	0	–	0	–	0	–	0	–	0	–

mAPD: median APRPD(1st quartile to 3rd quartile)

significantly different between the PHN and AHN groups ($p < 0.05$), there was no difference between the PHN and AHN groups in the APRPD after 12 months of age (Table 3).

Discussion

Hydronephrosis presents with various pathological conditions depending on the degree of ureteropelvic obstruction. Complete ureteropelvic obstruction leads to the abolishment of renal function and the development of polycystic kidney disease, whereas incomplete obstruction results in perturbed renal function varying from normal to severely impaired. Incomplete obstruction may cause progressive deterioration of renal function, and care must be taken during management of this condition. Although many postnatal management methods for AHN have been reported, the management method for PHN remains unclear because its clinical course is not well known. In this study, we aimed to clarify the clinical features and clinical course of PHN and to provide criteria for distinguishing cases that require careful follow-up from those that do not.

PHN was detected in 19.2% of neonates in this study. This rate is considerably higher than the previously reported incidence of AHN.[1-4] There was no particular difference in the perinatal history of pregnancy between cases with PHN and cases without PHN; since SFU grades of all PHN cases were less than 3, the obstruction was mild, and most PHNs disappeared spontaneously over time, it appears that the obstruction was caused by insufficient maturation of ureteropelvic or vesicoureteral junctions in many neonates, which matured over time. The left-right ratio was approximately four times higher on the left side, and 29.9% of the PHNs were bilateral. The male-female ratio was skewed to males (1.5 times). The epidemiological features of sex ratio and laterality of PHN showed a tendency similar to that of AHN reported previously, [6-10] and it is presumed that PHN has the same background and pathological conditions as AHN. During follow-up, four patients (1.6%) were found to have UTIs and underwent VCUG; VUR was observed in two (0.8%). Hubertus *et al.* [11] conducted a large cohort study of ureteropelvic junction obstruction (UPJO) to determine the incidence of concomitant VUR and showed that VUR was associated with 7.3% of the UPJO cases. The incidence of concomitant VUR in this study was much lower than that reported previously, suggesting that asymptomatic VUR could occur 10 times more frequently than UTI-caused VUR.

Table 3: Clinical course of mAPD for PHN and AHN during the observation period.

at birth		PHN	AHN	*p*
		n=317	n=14	
	mAPD	2.2(2.1-3.1)	3.5(2.8-7.0)	0.02
1 month				
		n=158	n=10	
	mAPD	3.5(2.7-4.5)	5.2(3.2-7.6)	0.13
6 months				
		n=36	n=8	
	mAPD	3.6(2.7-5.6)	4.0(2.5-8.5)	0.33
12-24 months				
		n=49	n=8	
	mAPD	4.1(3.1-5.5)	7.4(3.3-8.4)	0.08

mAPD: median APRPD

Table 2 shows the clinical courses of SFU and mAPD in patients with PHN. Although the SFU grades of some kidneys increased during the course of PHN, these changes disappeared approximately at 2 years of age, and the prognosis was good. The mAPD increased over time, suggesting that larger the mAPD, the longer it took for it to disappear. It has been pointed out that there is no standard APRPD value for assessment of PHN [12-13], and there are no clear criteria that can predict which kidney will eventually require surgical intervention. Clear criteria need to be set to accurately assess renal pelvic dilatation using the APRPD. In this study, the APRPD was measured in all kidneys with a dilated renal pelvis at birth, and the clinical course was observed. In most cases, the hydronephrosis disappeared over time. An APRPD within the interquartile range in this study could be considered to have a good prognosis. We believe that an APRPD within the interquartile range can be proposed as a reference value for hydronephrosis in patients with good prognosis. In this study, AHN was examined as a reference in addition to PHN. Resolution of PHN and AHN with SFU grades ≤2 was observed after 12 months of age. There was a significant difference in the mAPD only at birth. It became clear that the difference in APRPD between PHN and AHN decreased with age and eventually followed the same clinical course. Since ultrasound screening was performed on more than 1,000 neonates born in the regional core

hospital during this study, we believe that the epidemiological findings of PHN were somewhat reliable. However, since rare urinary diseases were not included, it is necessary to carry out ultrasound screening for more neonates.

Conclusion

This study revealed that the clinical course of PHN from the neonatal period to late infancy is a dynamic process that fluctuates over time under various conditions. Most cases of hydronephrosis detected during the perinatal period are mild and resolve spontaneously. However, in some cases, hydronephrosis can worsen over time. If neonatal hydronephrosis is encountered, cases with APRPD within the interquartile range (2.1-3.1 for SFU1, 4.5-4.9 for SFU2) are treated as having a good prognosis. If hydronephrosis disappears, follow-up can be completed in less than 2 years. In cases wherein hydronephrosis exceeds the interquartile range (>3.1 for SFU1, >4.9 for SFU2), careful follow up is required every 6 months until hydronephrosis completely disappears for 2 years or more, considering the possibility that hydronephrosis will persist or increase.

Declaration of interest

None

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Data availability

The data supporting the findings of this study are available upon request from the corresponding author. The data are not publicly available because of privacy concerns.

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