

# Antenatal hydronephrosis: a single center's experience and follow-up strategies

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This study was performed to evaluate the role of postnatal ultrasonography (US) in predicting the final diagnosis and need of surgery of antenatal hydronephrosis patients. One hundred and twenty six renal units (RUs) of 76 patients with diagnosis of antenatal hydronephrosis (ANH) were studied. An early postnatal US no later than the first week of life was requested. Voiding cystourethrography (VCUG) and/or diuretic renogram (MAG3) was performed in children who had persistent or worsening hydronephrosis to make a certain diagnose of etiology. US findings of different etiologies, and operated/nonoperated groups are compared. Regarding the renal pelvic anteroposterior diameter in the first week postnatal US; mild, moderate, severe, and no HN was detected in 48 (38.1%), 31 (24.6%), 24 (19.0%), and 23 (18.3%) RUs respectively. Eight RUs with a normal first postnatal US were found to have renal anomaly during follow up and 63% of these were vesicoureteral reflux (VUR). Kidneys with mild or moderate HN were likely to have transient dilatation while severe HN was likely to have obstruction. Postpartum follow-up of ANH is a dynamic process. Follow-up must be planned with optimum period of intervals according to clinic and US findings, to select the right patient for surgery or close follow-up.

**Key words:** antenatal hydronephrosis, postnatal management, ultrasound

Hydronephrosis (HN) is the most common congenital genitourinary system anomaly detected by antenatal ultrasounds (US) with a prevalence of 1-5%<sup>1,2</sup>. Antenatal hydronephrosis (ANH) represents a wide spectrum of urological conditions, ranging from transient dilatation of the collecting system to urinary tract obstruction or vesicoureteral reflux (VUR), which can cause chronic renal disease when not treated<sup>3</sup>. Although most of cases are benign and likely to resolve at the end of pregnancy or within the first year of life, many children undergo unnecessary extensive prenatal and postnatal imaging. Lee et al.<sup>4</sup> suggests that specific findings on prenatal US such as renal pelvic anterior-posterior (AP) diameter can help to predict the risk for postnatal pathologies and can be used to

determine which patients will require postnatal evaluation. Unfortunately in our study, the prenatal US findings were not sufficiently detailed on the grade of hydronephrosis or the AP diameter measurements. Therefore, management decisions are usually based on postnatal US findings. Our scope is to examine our population and compare postnatal US findings with final diagnosis and surgery necessity.

## Material and Methods

After the local ethical committee approval, we prospectively examined 76 patients with a diagnosis of ANH, who attended our Center's Pediatric Nephrology Clinic, from February 2006 to November 2008. Patients' demographic data, age, radiological findings and final diagnosis

were recorded. An early postnatal US, no later than the first week of life, was requested for ANH nasis diagnosis. Patients grouped according to these US findings. Follow ups were done by adequate serial USs. Second US done to 74 (97.4%) patients at median 3<sup>rd</sup> month; 3<sup>rd</sup> US done to 52 (68.4%) patients at median 6<sup>th</sup> month, 4<sup>th</sup> US done to 23 (30.3%) patients at median 9<sup>th</sup> month, 5<sup>th</sup> US done to 11 (14.5%) patients at median 14<sup>th</sup> month, 6<sup>th</sup> US done to 6 (7.9%) patients at median 20<sup>th</sup> month. Renograms and voiding cystourethrography (VCU) were done to determine the certain etiology of ANH with persistent or worsening hydronephrosis. In patients who attended at an older age, the data of the previous imaging studies were recorded. Prenatal US findings were recorded if they were available.

All antenatal and postnatal US findings were classified according to the classification suggested by Lee et al.<sup>4</sup> (Table 1).

Diuretic renogram with Tc-99m MAG- 3 was performed in 62 infants with persistent or worsening hydronephrosis, preferably after 6 months old. VCU was performed in 55 children who had persistent/worsening or bilateral HN, duplex kidney, urinary tract infection or ureteral dilatation detected in US.

According to the US, MAG3 and VCU results patients diagnosed in 4 groups as normal, non-obstructed dilatation, vesicoureteral reflux and obstruction (UPJO, UVJO, PUV). Pre-postnatal US findings of different diagnoses and surgery/follow groups are compared.

SPSS for Windows 15.0 is used for statistical analysis. The distribution pattern of the variables are examined. Non-parametrical tests were used for the variables that did not have a normal distribution pattern. Pearson chi square test was used for the comparison of independent groups.

## Results

Seventy-six patients with ANH were examined. Twenty-five patients (32.9%) were female and 51 (67.1%) were male. The median age of admittance to the hospital was 2.5 months. (0- 19 months). 126 hydronephrotic RUs were included. Patients were followed up for 24 months.

All patients had prenatal US study but data

about renal pelvis AP diameter was available in only 36 RUs. In the 36 RUs, mild, moderate or severe hydronephrosis was detected in 20 (55.6%), 9 (25.9%) and 7 (19.4%) RUs, respectively. In this group with defined AP diameters, there was no correlation between the degree of hydronephrosis in the prenatal period and the risk of vesicoureteral reflux (VUR) (chi-square test  $p=0.22$ ) or obstruction (chi-square test  $p= 0.07$ ).

Regarding the renal pelvic AP diameter in the postnatal US of the patients with ANH, 48 (38.1%) RUs had mild, 31 (24.6%) had moderate, 24 (19.0%) had severe hydronephrosis and no hydronephrosis was detected in 23 (18.3%). During the follow up of normal first postnatal US RUs ( $n=23$ ), abnormal findings were detected in 8 (35%) (5 VUR, 1 UPJO, 1 duplex system, 1 renal agenesis) and 4 of these patients needed surgical intervention. The vast majority of renal anomalies of RUs with a normal first postnatal US were VUR (63%).

In the follow up, VCU was performed in 55 patients at a mean age of  $4.0\pm 3.8$  months. VUR was identified in 14 patients (13 unilateral, 1 bilateral). Thirty-three percent of RUs with VUR had a normal first postnatal US, meaning that absence of hydronephrosis in postnatal US does not rule out presence or development of VUR. Presence of reflux between the different hydronephrosis grades were statistically same (chi-square test,  $p=0.59$ ) (Fig. 1). The distribution of grades of finally VUR diagnosed RUs according to the first postnatal hydronephrosis groups were; for normal US group: 1RU Grade 2, 3 RUs grade 3, 1 RU grade 4; for mild hydronephrosis group: 1 RU grade 2, 4 RUs grade 3, 1 RU grade 4; for moderate hydronephrosis group: 1 RU grade 4, 2 RUs grade 5; for severe hydronephrosis group: 1 RU grade 5 refluxes. Also the hydronephrosis grades for refluxing and nonrefluxing RUs were statistically same (chi-square test  $p= 0.30$ ).

Diuretic renogram study was performed in 62 patients (122 RUs) at a mean age of  $3.8\pm 2.7$  months. Regarding diuretic renogram findings, 1 of 23 RUs with a normal first postnatal US had obstruction. Number of obstructed systems increases as grade of hydronephrosis increasing in first postnatal US (chi-square test,  $p<0.001$ ) (Fig. 2).

At the end of the follow up, 44 RUs (34.9%) were normal; transient dilatation was detected in 42 (33.3%), VUR in 15 (11.9%), UPJO in 11 (8.7%), UVJO in 3 (2.4%), PUV in 2 (1.6%), double collecting system in 2 (1.6%), ectopic ureter in 2 (1.6%), megaureter in 3 (2.4%), renal agenesis in 1 (0.8%), and multicystic dysplastic kidney in 1 (0.8%) RUs. A statistically significant relationship is detected between the grade of hydronephrosis and the incidence of urinary anomaly ( $p < 0.001$ ) but grade is not a predictor of the type of urinary anomaly, i.e. if it is VUR or obstruction.

Eleven patients with 13 RUs had surgery due to different etiologies (3 UNC, 3 UP plasty, 1 ureterocutaneous, 1 PUV ablation, 1 simple nephrectomy, 1 cystoscopy). Mean of maximum AP diameters within first year of life was higher in the surgery group than the followed-up group ( $20.9 \pm 12.5$  mm vs.  $10.8 \pm 5.5$  mm;  $p = 0.024$ , T-Test). ROC analyses of the maximum AP diameters within the first age was performed to find out a cut-off value to predict a possible surgery need is 10.25 mm (DA:72.5%, PPV:68.6%, NPV:77.7%, sensitivity 81.8%, spesificity:63.3%). Also specificity and sensitivity for 15 mm is identified (DA: 78.8%, PPV: 37.5, NPV: 90%, sensitivity 54.5%, specificity: 83.3%).

## Discussion

In this study we evaluated patients with antenatal hydronephrosis. The detailed data of prenatal US findings was available in only 36 RUs, and the AP pelvic diameter measures were missing in the rest. There was no relation between the grade of hydronephrosis in the antenatal period and the risk of VUR ( $p = 0.22$ ). On the other hand, the grade of hydronephrosis in the antenatal US tends to correlate with

risk or obstruction ( $p = 0.07$ ), although not reaching statistical significance, probably due to small size of our sample. This is parallel to results reported previously by Lee et al.<sup>4</sup> who showed that the incidence of postnatal pathology except VUR increased as the grade of prenatal hydronephrosis increased.

We also analyzed correlation of postnatal 1st week US findings and final diagnoses. Rate of normal scintigraphy RUs in non-HN group is 57.1% (12/21 RUs), which decreases to 18% (4/22 RUs) in severe HN group but still exists. On the other hand, rate of obstructed RUs in non-HN group is 4.8% (1/21 RUs) and rises to 54.5% (12/21 RUs) in severe HN group (Fig. 2). Although risk of VUR tends to decrease as grade of HN increase from normal to severe, this is not statistically significant ( $p = 0.30$ ). These results can be interpreted in different ways. The risk of urinary pathology in non-HN group is 29%. In this study, out of 23 normal RUs, 8 (35%) had urinary system pathology as final diagnoses and 2 of them required surgical intervention. So, despite normal early postnatal US, follow-up must be continued for 1 year without hydronephrosis and parents must be warned about UTI and pain before ceasing the follow-up. On the other hand, 45% of severe HN patients are normal or have transient dilatation as final diagnoses (Fig. 1). The clinician must be aware of this subgroup of patients to avoid unnecessary surgical intervention.

When we compared AP renal pelvis diameters of the patients who required surgery for any reason and the patients who did not, we found that the mean of maximum AP diameters within first year of life was higher in the surgery group than the followed-up group ( $20.9 \pm 12.5$  mm vs.  $10.8 \pm 5.5$  mm;  $p = 0.024$ , T-Test), in parallel

**Table I.** Classification of Hydronephrosis According to the Pre-Postnatal US Findings<sup>4</sup>

	Renal pelvic AP diameter (mm)		
	2nd trimester	3rd trimester	Postnatal period
Mild hydronephrosis	$\leq 7$	$\leq 9$	$\leq 9$
Moderate hydronephrosis	7- 10	9- 15	9- 15
Severe hydronephrosis	$\geq 10$	$\geq 15$	$\geq 15$

AP: Anteroposterior

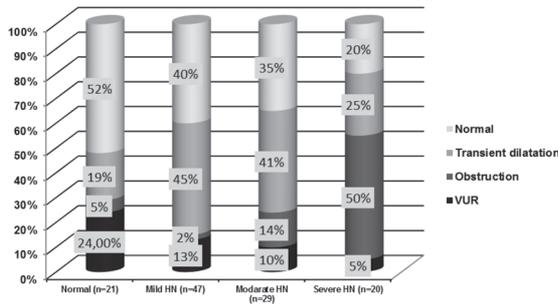


Fig. 1. Comparison of the final diagnoses with the grade of hydronephrosis (HN) in the first postnatal US (megaureter, renal agenesis, MCDK; ectopic ureter & doublex collecting system RUs, total 9 RUs, are excluded).

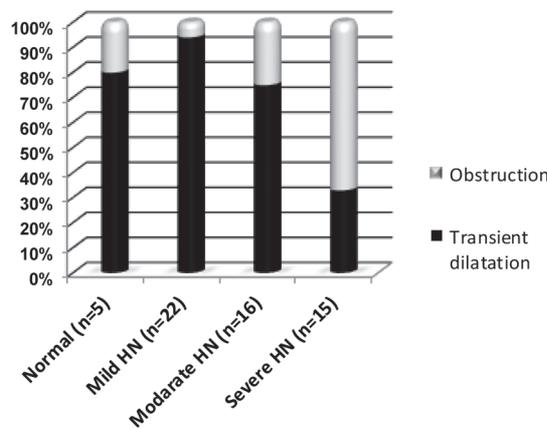


Fig. 2. Comparison of grade of hydronephrosis (HN) in the first postnatal US and final diagnosis of obstruction / transient dilatation

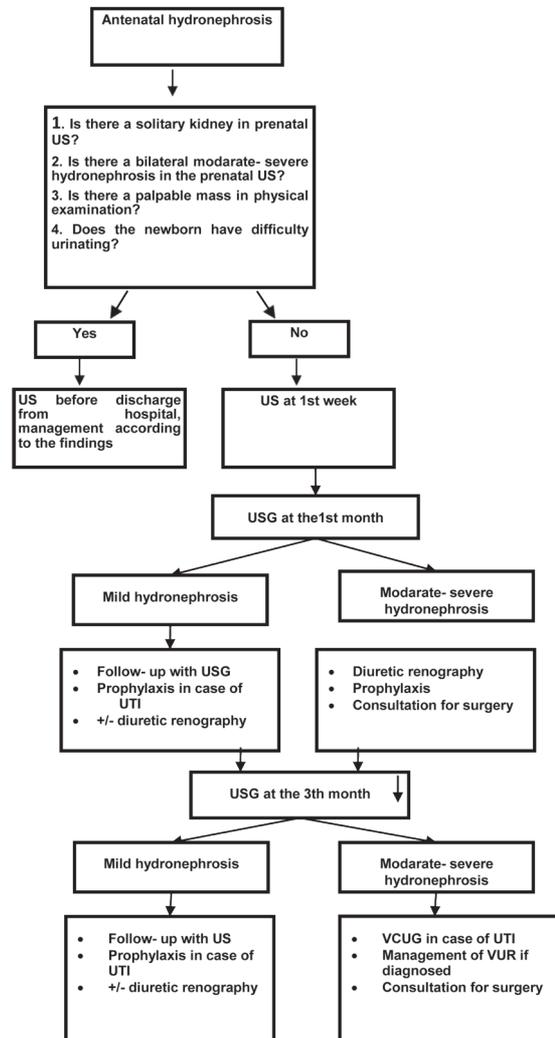


Fig. 3. Algorithm for managing a newborn with antenatally detected hydronephrosis

to previous literature [5]. ROC analyses of the maximum AP diameters within the first age was performed to find out a cut-off value to predict a possible surgery need is 10.25 mm (DA: 72.5%, PPV: 68.6%, NPV:77.7%, sensitivity 81.8%, specificity:63.3%). Because the sensitivity for 15 mm is so low, according to our data, we recommend closer follow-up for the patients with AP diameters larger than 10mm.

Though the literature is extensive, there is no consensus about follow up of antenatally detected hydronephrosis in the postnatal period. The initial postnatal evaluation includes US, VCUG, diuretic renogram, and rarely, magnetic resonance imaging. US is the most common

Table II. Criteria for Surgery.

Symptoms
• AP diameter >30 mm
• AP diameter >20 mm with calyceal dilation
• Renal function <30%
• Worsening renal function
• Worsening hydronephrosis

AP: Anteroposterior

imaging modality serving to monitor urinary tract. However hydration status, bladder filling and operators' skill have been shown to influence the predictive value of this imaging modality<sup>6</sup>.

Voiding cystourethrography is frequently performed in conjunction with renal studies to rule out VUR as the cause of hydronephrosis. The overall incidence of VUR is up to 30% of children with antenatal hydronephrosis, including those with resolved hydronephrosis<sup>4,7</sup>. It is controversial whether the identification and treatment of children with asymptomatic VUR confers any clinical benefit<sup>8</sup>. Most patients with VUR and low-grade hydronephrosis can be followed without surgical intervention<sup>9</sup>. Hence, routine use of VCUG in the work-up of ANH will cause overdiagnosis of clinically insignificant VUR cases.

Renal scintigraphy is considered to be useful to estimate differential renal function and analyze the severity of obstruction. It should be performed no earlier than 6 weeks to allow renal maturation. Differential renal function <40% with impaired drainage (as indicated by  $T_{1/2} > 20$  min) or worsening renal function are often indicative for pyeloplasty<sup>9</sup>.

For unilateral fetal hydronephrosis with a normal contralateral kidney, postnatal evaluation should begin within the first week of life with a renal US<sup>6,7</sup>. For bilateral hydronephrosis and hydronephrosis in solitary kidneys or in patients with suspected bladder outlet obstruction, early postnatal imaging (before newborn discharge from hospital) is suggested<sup>9</sup>. We suggest an algorithm for the evaluation of the newborn with fetal hydronephrosis (Fig. 3). We do not recommend an US before the first week of life unless there is solitary kidney, bilateral moderate - severe hydronephrosis, palpable mass or difficulty in urinating.

Several studies have demonstrated that a single normal US within the first week of life is not adequate to verify absence of obstruction. A second US at 1 month of age is recommended as initial follow-up testing<sup>9</sup>. The incidence of late, worsening or recurrent hydronephrosis is approximately 1-5%<sup>10,12</sup>. Some practitioners recommend discharging children with mild or moderate hydronephrosis on the 1- month US from further surveillance

with the recommendation of visiting the child for UTI or pain, while others recommend serial US and UTI surveillance every 6-12 months<sup>13</sup>. On the other hand, Society of Fetal Urology recommends that if the infant has a history of antenatally detected hydronephrosis which resolves in the postnatal period, follow up US should be performed at 3-6 months or 1 year old, depending on the severity of hydronephrosis<sup>9</sup>. For persistent hydronephrosis they recommend renal US every 3 months until age 6 months and every 6 months until age 2 years<sup>14</sup>. Considering the literature and our results, we recommend a second US in 1 month even if the first postnatal US is normal. In our study 97% patients has 2<sup>nd</sup> US at mean  $3.7 \pm 3.6$  months. Number of US depends on patient's clinic need. Our 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup>, USs done at  $7.6 \pm 5.0$ ;  $9.0 \pm 3.8$ ;  $14.6 \pm 8.0$ ;  $18.6 \pm 5.8$  months, respectively.

Mild hydronephrosis should be followed with US. VCUG and/or renal scintigraphy should be limited to cases like persistent/worsening or bilateral hydronephrosis, duplex kidney, ureteral dilatation detected in US or urinary tract infection. US should be performed at one week, one month of age and repeated in 3 month intervals until the first birthday. If the findings of the USG performed at the 1st week and the 1st month are normal, the baby is ceased from follow- up and the parents are advised to revisit in case of UTI or pain.

For moderate to severe hydronephrosis, we suggest to visit the patient at one week, one month and then in 3 months intervals. We suggest renal scintigraphy to see differential renal function and rule out obstruction. Consultation for surgery is requested according to the criteria given by Yiee et al.<sup>15</sup> (Table II).

Although, prenatal and postnatal USG surveillance carries the risk of over diagnosis of cases with low clinical importance, it still is the best way of catching the important, particularly the obstructive, patients. The diagnostic yield of US for VUR seems low, however it is invaluable for obstructive cases. The degree of hydronephrosis is significantly predictive for obstruction and our results revealed that hydronephrosis in association with an AP diameter more than 10 mm deserves close follow-up in the postnatal period.

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