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First Postnatal Ultrasound Scan to Predict the Outcome of Antenatally Diagnosed Hydronephrosis

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Abstract

Purpose: *To determine if anteroposterior renal pelvic diameter (APD) on the first postnatal ultrasound (US) scan can predict outcomes in children with antenatal hydronephrosis (ANH).*

Method: *Data on all babies with ANH born in our center from 2009–2015 was obtained from the National Congenital Anomaly and Rare Disease Registration Service (NCARDRS). The medical records were reviewed. Statistical analysis was performed on GraphPad.*

Results*: 223 babies were included in the study. 165 (74%) had spontaneous resolution of hydronephrosis. The mean APD on the first US was 13.3 mm in children whose ANH was resolved and 25.3 mm in those with persistent ANH ($p < 0.01$). 50 procedures were performed on 37 children. The most common procedure was pyeloplasty ($n = 15$), followed by total or partial nephroureterectomy ($n = 12$). 21 children had persistent dilatation but needed no intervention. Renal duplex ($n = 8$) was the most common diagnosis in this group (persistent dilatation) followed by vesicoureteric reflux (VUR) ($n = 7$). All babies with APD > 24 mm on their first US required surgical intervention.*

Conclusion: *While most ANH resolves spontaneously, children with higher APD in the first US have a higher likelihood of subsequent surgery. All children with APD > 24 mm require surgery. This information is beneficial in postnatal counseling for children with ANH.*

Keywords: antenatal hydronephrosis, ultrasound scan, outcomes, surgical intervention

Abbreviations: APD: anteroposterior renal pelvic diameter; US: ultrasound; ANH: antenatal hydronephrosis; NCARDRS: National Congenital Anomaly and Rare Disease Registration Service; SFU: Society for Fetal Urology; VUR: vesicoureteric reflux; MCDK: multicystic dysplastic kidney; PUJO: pelviureteric junction obstruction; PUV:

posterior urethral valves; APRPD: antero-posterior renal pelvis diameter; VCUG: voiding cystourethrography; UPJO: ureteropelvic junction obstruction

Introduction

Antenatal hydronephrosis (ANH) is the most common antenatal renal anomaly noted in about 0.6–5.4% of pregnancies [1]. According to the Society for Fetal Urology (SFU), in the third trimester, an anteroposterior renal pelvic diameter (APD) of 7–9 mm is mild, 10–15 mm moderate, and > 15 mm is severe hydronephrosis [2–4]. Most infants with ANH are entirely asymptomatic at birth, and most would resolve spontaneously. Therefore, it is challenging to identify the hydronephrosis that would cause renal functional loss if left untreated [5]. The standard early postnatal investigation for babies with ANH is renal ultrasound (US) [6]. This study aimed to determine the role of the first postnatal US in predicting the outcome of children with ANH.

Methods

A list of babies born with ANH was obtained from the National Congenital Anomaly and Rare Disease Registration Service (NCARDRS). The babies born at our center from 2009–2015 were included in the study. The babies whose postnatal US was not performed at our center and those who died in the immediate postnatal period were excluded.

The medical records were analyzed in 2019 to collect diagnosis, investigations, surgery, and follow-up data.

The children were divided into two groups; Group A, in which the hydronephrosis resolved, and Group B, where the hydronephrosis persisted during the study period and required surgery or ongoing monitoring. In some children, the hydronephrosis resolved, but another urological condition was identified, such as duplex or vesicoureteric reflux (VUR) requiring ongoing management. These children were included in Group B for analysis.

The student's t-test and Fisher's test were used to analyze the data using GraphPad Prism 9.

Results

233 babies were liveborn during the study period.

We excluded 4 babies due to incomplete records, and 6 died in the immediate newborn period. Therefore, data from the remaining 223 babies were analyzed.

The median gestational age at delivery was 39 weeks (IQR: 38 - 40), and the mean birth weight was 3.43 kg (IQR: 3.01 - 3.84). The median age at first postnatal US was 8 days (IQR: 6 - 12). 153 (69%) were males, and 85 (38%) had bilateral hydronephrosis. Of the 138 unilateral hydronephrosis, 81 (59%) were left-sided. The median follow-up was 14 months (IQR: 2 - 44).

165 (74%) had spontaneous resolution of hydronephrosis, of which 88 (39%) resolved at the first US. Of the 88 children whose first postnatal US was normal, 18 underwent further US scans, which remained normal.

In the 77 babies with hydronephrosis on the first scan which later resolved, the median age at resolution was 399 days (IQR: 102 - 1048). During follow-up, 36 children had MAG3 renogram, and none showed obstruction. 24 children had a micturating cystourethrogram, but no reflux was detected. 29 children had DMSA scans, one had right-sided renal scarring with 31% function which was managed conservatively.

Resolution rates for unilateral and bilateral hydronephrosis were similar (Table 1).

Total (n = 223)			
Unilateral (n = 138)		Bilateral (n = 85)	
Group A - 104 (75%)	Group B - 34 (25%)	Group A - 61 (72%)	Group B - 24 (28%)

Table 1: Number of children with hydronephrosis. Fisher's exact test: two-tailed P value = 0.64.

The resolution of right and left-sided ANH was similar as well (Table 2).

Total (n = 138)			
Left (n = 81)		Right (n = 57)	
Group A - 64 (79%)	Group B - 17 (21%)	Group A - 40 (70%)	Group B - 17 (30%)

Table 2: Number of children with unilateral hydronephrosis. Fisher's exact test: two-tailed P value = 0.32.

The baby's gestational age and birth weight did not affect the resolution rates (Fisher's exact test: two-tailed P value = 0.94 and 0.81, respectively). Resolution rates were not different among male (75%) and female (71%) babies (Fisher's exact test: two-tailed P value = 0.51).

The mean APD of Group A was significantly lower than Group B (Table 3).

Groups	Q1	Median	Q3	Mean	SD
Group A	11	12	15	13.33	03.24
Group B	16	21	27	25.27	17.34

Table 3: Comparison of APD (mm). Unpaired t-test: the two-tailed P value < 0.01.

The highest APD that underwent spontaneous resolution was 24 mm. The largest APD recorded was 95 mm in a baby with VUR who required a nephroureterectomy later. All babies with APD of 25 mm or above on their first postnatal US had persistent renal dilatation and required intervention afterward.

The diagnoses of 58 children in Group B are summarized in the table (Table 4).

Diagnosis	Surgery needed	No surgery	Total
Vesicoureteric reflux	10	9	19
Pelviureteric junction obstruction	15	0	15
Duplex kidney	4	10	14
Dysplastic kidney	4	4	8
Megaureter	4	1	5
Urethral valves[a]	4	0	4
Horseshoe kidney	0	1	1
Total	**41**	**25**	**66**

Table 4: Diagnosis in each renal unit in Group B. [a]In urethral valves, both kidneys are considered as one unit.

9 children in Group B did not have an APD to suggest hydronephrosis, but they had other renal tract abnormalities on the first US. For example, 3 children had multicystic dysplastic kidney (MCDK), and 6 had ureteric dilatation. Of the 6 children with ureteric dilatation, 4 had duplex, and 2 had reflux.

The renal units were divided into 2 groups based on the APD above or below 20 mm (Table 5). It demonstrated that APD on the first postnatal US associated with pelviureteric junction obstruction (PUJO) and posterior urethral valves (PUV) are usually above 20 mm, while APD associated with VUR and dysplastic kidneys are usually below 20 mm.

Diagnosis	> 20 mm	< 20 mm	Total
Vesicoureteric reflux	2	17	19
Pelviureteric junction obstruction	13	2	15
Duplex kidney	5	9	14
Dysplastic kidney	0	8	8

Megaureter	2	3	5
Urethral valves[a]	4	0	4
Horseshoe kidney	0	1	1
Total	**26**	**40**	**66**

Table 5: APD in each kidney above and below 20 mm in Group B. [a]In urethral valves, both kidneys are considered as one unit.

50 procedures were performed on 37 children who required surgery. The most common procedure was pyeloplasty, followed by total or partial nephroureterectomy (Table 6).

21 patients continued to have persistent dilatation but did not require any surgical intervention.

Pyeloplasty	15
Nephroureterectomy (total/partial)	12
Endoscopic correction of reflux	6
Ureteric reimplantation	4
Ablation of urethral valves	4
Circumcision	3
Ureteric stents	2
Ureteroureterostomy	1
Suprapubic catheter	1
Bladder augmentation	1
Renal transplant	1
Total	**50**

Table 6: Surgical procedures performed.

Discussion

An increasing number of kidney anomalies are detected by fetal sonography in otherwise uncomplicated pregnancies and widespread prenatal screening during pregnancy has been responsible for this [4–6]. ANH is defined as dilation of the renal pelvis and/or calyces and is generally postulated as a marker of congenital abnormalities of the kidney and urinary tract [6]. It is one of the most common birth defects and affects approximately 1–5% of all pregnancies [5].

The postnatal outcome of ANH has been extensively studied [7]. However, a systematic review of the predictive value of the first postnatal US in children with ANH failed to identify good-quality data [8]. In addition, no studies from the United Kingdom on this topic exist. Therefore, the generalizability and transferability of the findings of external studies to the UK population have not been evaluated either.

The management of ANH remains a challenge due to the variability in outcomes and the lack of consensus regarding optimal diagnostic and treatment protocols [9]. Previous studies have reported conflicting results regarding the predictive factors for spontaneous resolution *vs.* those requiring intervention, including the degree of hydronephrosis, the presence of associated anomalies, and renal function [10, 11].

We collected the data on ANH from NCARDRS. All antenatal scans with anomalies are reported to NCARDRS. Therefore, the data should include all babies who had an antenatal diagnosis of hydronephrosis documented in their fetal scans within the study period. In addition, our center is the only regional Paediatric Urology center in Northeast England. Therefore, children in this region will have urology follow-up in our center only. We included all ANHs irrespective of the grade in this study.

To standardize the grading of ANH, the SFU introduced a five-point grading system in 1988, based on the degree of pelvic and calyceal dilation and the thickness of the parenchyma overlying the calyces [12]. APD measurements and SFU grades are the two most commonly used grading systems for ANH [13]. In our center, APD is used for grading

postnatal hydronephrosis. Since its introduction, the SFU grading system has become the most widely used method to grade pediatric hydronephrosis [12, 13]. According to SFU, ANH is classified as mild if antero-posterior renal pelvis diameter (APRPD) was 4–6 mm in the second trimester and 7–9 mm in the third trimester; moderate if 9–15 mm in 3rd trimester and severe if APRPD was > 10 mm and > 15 mm in the second and third trimester, respectively. Similarly, neonatal hydronephrosis is diagnosed when APRPD ≥7 mm in the postnatal US scan [12, 13].

Based on antenatal findings, all these babies will have a postnatal scan; the timing of which is determined by the severity of ANH. Besides it has been shown that the likelihood of resolution is related to the severity of the APRPD at initial diagnosis, making the postnatal evaluation highly relevant. During prenatal evaluation, the cause of ANH cannot always be determined with certainty [5]. Thus, the principal objective of the first postnatal scan is to confirm the prenatal findings and facilitate an accurate diagnosis [4–6]. In a recent study published in China [14], a retrospective review of 1137 babies with ANH revealed that 58.5% of those who had postnatal follow-up had associated malformations diagnosed only in the postnatal period; highlighting the significance of postnatal evaluation in these babies.

However, an initial normal postnatal US in children with ANH can often be misleading. Aksu et al. [12] observed that 45% of the children with an initial normal first postnatal scan had an abnormal US at follow-up. In another study, 5% of the patients requiring surgery for obstructive uropathies had a normal US at the first week of gestation but an abnormal scan at 1 month of age [15]. Therefore, they suggest that in children with ANH, a second postnatal US should be performed even if the first one is normal. In our series, some children whose first US was normal underwent further US, but none developed hydronephrosis. Therefore, we found the first US to be a very reliable tool for confirming the resolution of ANH. In addition, we have reviewed the medical records for at least five years after diagnosis and none of these children represented symptoms.

It is reported that the causes of ANH are transient hydronephrosis (41–88%), PUJO (10–30%), VUR (10–20%), megaureters (5–10%), duplex (5–7%), MCDK (4–6%), PUV (1–2%) [3]. Our findings are similar, but we found VUR more common than PUJO in our series. Our resolution rates (transient dilatation) and the observed spectrum of diseases presenting as ANH are similar to other published papers [8, 10, 11]. Considering all patients with any degree of ANH, Lee et al. [7] reported that 36% had a pathology discovered during postnatal management. Our series shows similar findings, where in Group B (persistent dilatation) 26% unilateral and 26% bilateral cases of ANH were eventually diagnosed with VUR, followed by 29% unilateral and 15% bilateral ANH later diagnosed with PUJO. In most children with bilateral ANH and PUJO, hydronephrosis on one side has resolved. We only had one child in this series who required bilateral pyeloplasty for PUJO.

Most antenatally detected hydronephrosis is a transient dilatation that resolves during follow-up [1]. It may be related to natural kinks and folds that occur during embryological development and then disappear with maturation [1–3]. Mild prenatal hydronephrosis may be an expression of the physiological changes associated with normal growth and development of the fetal renal pelvis, coupled with increased fetal urinary output [1].

In our series, the rate of spontaneous intrauterine resolution of antenatal dilatation was 36.7% (n = 86/234) evident by normal findings on the first postnatal scan. Subsequently, on routine follow-up, a further 32.9% (n = 77/234) showed complete resolution. Mallik et al. [16] conducted a prospective study of 165 infants with ANH to define their natural history. Transient hydronephrosis was detected in 69.69% of all infants. The rate of transient hydronephrosis decreased from 80.6% in infants with normal first postnatal US to 3.7% in infants with severe hydronephrosis on first postnatal US. Given such natural history, it is thus even more important to determine which group of ANH are at risk of permanent kidney damage and those who are not; a fact which we attempted to address in this study.

In our study, 75% of unilateral ANH underwent resolution while 72% of bilateral cases showed resolution of dilatation on serial postnatal follow-up. While looking into the literature, Leong et al. [17] carried out a comparative study to compare the outcomes of bilateral hydronephrosis with unilateral cases and found that 42% had complete resolution within a year in both groups. There was no statistically significant difference in outcomes (p = 0.07). This was the

first report of newborns with bilateral isolated hydronephrosis with an APPD of ≤15 mm conservatively managed without antibiotic prophylaxis or voiding cystourethrography (VCUG). They concluded newborns with bilateral mild hydronephrosis that is not associated with other morphological renal tract abnormalities, the prognosis will be good, like that of newborns with unilateral hydronephrosis; therefore, neither VCUG nor antibiotic prophylaxis is justified. Similar data were observed by Mamì et al. [13] who found a complete resolution of bilateral hydronephrosis postnatally in all infants with an APPD of ≤15 mm after a follow-up of 12–14 months. Thus, it is probably justified to state that bilateral mild isolated hydronephrosis is a very frequent finding with a very good prognosis. The results of our analysis suggest that when hydronephrosis is mild and not associated with other urinary tract abnormalities, bilateralism does not imply a higher risk.

Studies on the resolution of antenatally detected hydronephrosis are generally heterogeneous and include all etiologies such as ureteropelvic junction obstruction (UPJO), VUR, PUV, and primary megaureter [12]. The wide range of spontaneous resolution rates in these studies (57–98%) indicates that resolution is highly dependent on the primary pathology. In our series, the cohort with postnatal APRPD of 24 mm or less (SFU grade 3, intermediate risk) constituting 69.6% of the total showed complete resolution on follow-up.

Postnatal APDs < 20 mm are more likely to be at low risk for significant pathology, renal deterioration, and a subsequent need for surgery [13]. Our observations in this study differ in that some children with APD of < 20 mm still had renal pathology needing surgery. We observed one baby with an initial APD of 11 mm, eventually requiring pyeloplasty for progressive hydronephrosis. We also observed that 15 children with APD < 10 mm in the initial and subsequent US had underlying pathology of either reflux, duplex, or dysplastic kidney, and 6 of them required surgery. It is noticeable that in children with VUR, the APD remains stable despite disease progression. There is a poor correlation between the grade of reflux and the severity of ANH [11–14]. The other interesting observation was that all children with APD > 24 mm required surgical intervention, predominantly pyeloplasty. Arora et al. [18] reported the same finding in a prospective multivariate analysis. Therefore, high-grade ANH is usually PUJO [7].

When moderate or severe ANH is present on initial neonatal US, and VUR is not present, obstructive causes of hydronephrosis must be excluded. In the absence of a hydroureter or high-grade VUR, UPJO should be considered [5, 12]. Of the causes of hydronephrosis, PUJO accounts for approximately 10–65% of cases, and in 90% of cases, the obstruction is unilateral [19]. As the severity of hydronephrosis increases, the risk of PUJO also increases, and as much as 35% of significant hydronephrosis (> 10 mm APRPD postnatally) was attributable to UPJO in one study [20]. Lee et al. [7] showed a 54% risk of PUJO in severe (> 15 mm APRPD postnatally) urinary tract dilation. It is typically represented by severe hydronephrosis on postnatal imaging and so, the degree of postnatal hydronephrosis is predictive of the presence of PUJO. Thus, it is probably more justifiable to follow patients with APRPD 20–30 mm carefully and arrange further investigations if dilatation increases to more than 30 mm. Our reported pyeloplasty in the higher-grade ANH of dilatation of 25 mm or more was 35% and PUJO was diagnosed in 39.5% of persistent cases.

In a study aiming to predict the outcome of ANH, Longpre et al. [2] compared patients with ultimately resolved ANH to unresolved cases in terms of various variables. They found that multivariate analysis showed larger APD (hazard ratio 0.54; 95% CI 0.36-0.80) and SFU grade 4 (hazard ratio 0.34; 95% CI 0.13-0.90) to be associated with a significantly lower likelihood of resolution. The mean initial APD in resolved cases was 9.4 mm as opposed to 29.0 mm in cases requiring surgery with a p-value of 0.0001. They concluded a larger initial APD to have higher predictive value for surgical intervention. In a recent prospective study [21] from India, looking into outcomes of 150 women with ANH diagnosis mentions postnatally the mean APRPD in the resolved group was 5.2 mm, compared to 10.6 mm in the intervention group. In our cohort, the mean APD in resolved cases was 13.3 mm as opposed to 25.3 mm in cases requiring intervention.

Therefore, we recommend aggressive active monitoring for all initial APD > 24 mm and only investigate children with APD < 10 mm if they are symptomatic or those who have other renal tract abnormalities in the US. The optimal APD measurement for postnatal hydronephrosis is debatable. However, 97.5% of children with APD < 10 mm would resolve spontaneously without intervention [22].

One limitation of our study is its single-center design, which may limit the generalizability of our findings. Additionally, the arbitrary nature of some diagnostic criteria may introduce bias into treatment decisions.

Moreover, we did not collect exact antenatal renal pelvis dilatation measurements and therefore couldn't correlate with postnatal findings linking the two.

The arbitrary APRPD values used in our study serve as a practical tool for risk stratification and treatment decision-making in ANH. While these values may vary depending on population characteristics and imaging techniques, they provide a useful framework for identifying cases at higher risk of adverse outcomes and guiding clinical management and counseling of parents [21, 23].

Conclusion

While most ANH resolves spontaneously, children with higher APD in the first US have a higher likelihood of subsequent surgery. All children with APD > 24 mm require surgery. This information can be beneficial in postnatal counseling for babies with ANH. Our study provides valuable insights into the diagnosis, monitoring, and management of ANH, with a focus on first postnatal US scan findings and identifying cases that require intervention *vs.* those that are likely to resolve spontaneously. Future research should focus on validating these findings in larger, multicenter cohorts and refining prognostic thresholds based on longitudinal data. By elucidating factors predictive of outcomes, such as APRPD, we aim to optimize the care of infants with ANH and minimize the risks associated with unnecessary interventions.

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