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Original Article

Antenatal Ultrasonogram Detection of Fetal Urinary Tract Dilatation – Evaluation to form Guidelines for Postnatal Risk Stratification and Treatment Plan: A Single-center Study

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Abstract

Introduction: The incidence of antenatally detected genitourinary abnormalities is on the rise. Although this has led to earlier interventions and better prognosis, there is a lack of standardization and uniformity in the diagnosis of urinary tract dilatation (UTD) which has resulted in more confusion than before regarding the management. Entities such as "prominent pelvis," "pelviectasis," and "hydronephrosis" have been used without any objective criteria which lead to unnecessary and extensive postnatal evaluation.

Aim: This study aims to study the imaging features of those infants with antenatally diagnosed fetal urinary tract dilation and to standardize the protocol for postnatal follow-up and management.

Materials and Methods: A prospective study of 72 mothers who were antenatally diagnosed with fetal UTD were enrolled for the study and postnatal follow-up done by imaging with ultrasound, voiding cystourethrogram, and intravenous urogram.

Results: Among the 72 enrolled cases of 24 were categorized under UTD A1, nine children were managed conservatively with regular follow-up. Those categorized under UTD P1, six cases had normal postnatal scans at the 1st week of life and at 1 month, of which three cases had transient hydronephrosis and two had partial pelviureteric junction obstruction (PUJO). Of 14 children with intermediate-risk dilation UTD P2, 11 children had complete PUJO, two had partial PUJO, and one had bilateral vesicoureteric reflux (VUR), of which patients with complete PUJO required pyeloplasty and the rest needed only observation. Among the 20 neonates with UTD P3 high-risk dilatation, 10 cases of posterior urethral valve, six cases of complete PUJO, one case of obstructive megaureter, one case of VUR, one case of bilateral ureterocele, and one case of non-neurogenic bladder, all of which required surgical intervention except in case of VUR.

Key words: Fetal pyelectasis, Hydronephrosis, Pelviureteric junction obstruction, Urinary tract dilatation

INTRODUCTION

Hydronephrosis refers to the dilatation of the renal collecting system, regardless of the etiology. While pyelectasis or pelviectasis refers to the dilated renal pelvis, the term caliectasis is used when there is a dilatation of renal calyces. Earlier days, the clinical scenario of septicemia due to hydronephrosis associated with urinary tract abnormalities such as posterior urethral valve (PUV) was a common entity in pre-ultrasonogram era which is not much encountered nowadays because majority of them are detected during antenatal scans. The early demonstration of hydronephrosis provides an opportunity to preserve renal function by decompressing the obstructed collecting system immediately after birth and also timely treatment of recurrent urinary tract infections with antibiotic prophylaxis.[1]

Prenatal diagnosis of fetal urinary tract dilatation (UTD) improves perinatal management and the prognosis

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thereafter. The primary objective of prenatal ultrasound is to describe the pathology as accurately as possible, to exclude associated malformations, and to screen for parameters predictive of poor renal function, bringing up the necessity for a multidisciplinary perinatal approach.

In the era of ultrasound advancement, the incidence of antenatally detected abnormal renal sonogram is on the rise. Although this has led to earlier intervention and better prognosis in a subset of newborns, lack of standardization and uniformity in diagnosis of UTD has resulted in more confusion than before regarding the management. Another major problem is the subjective use of terminologies such as "prominent pelvis," "pelviectasis," and "hydronephrosis" without any objective criteria which lead to unnecessary and extensive postnatal evaluation.

The signs of functioning of the fetal metanephric kidney are seen as early as 9–12 weeks of gestation. Tubular reabsorption and functioning of Henle's loop begin by 14 weeks of gestation. The rate of fetal urine production relatively increases by 10 times as the gestational age progresses from 20 weeks to 40 weeks.[2] This results in total increase in fetal urinary output by 3-fold during 20–25 weeks and about 2-fold between 30 weeks and 40 weeks.[3]

While imaging the fetal renal pelvis by ultrasonogram, numerous physiological factors have been taken into account The extent to which the fetal bladder is distended and maternal hydration status during the time of sonographic study is also vital in demonstrating fetal pyelectasis.[4] There is a relative decrease in the size of the anteroposterior (AP) diameter of the fetal renal pelvis when the fetal bladder is empty and shows variability depending on the volume of the fetal bladder.[5]

Nephrogenesis continues up to 36 weeks of gestation and at birth in full-term infants, but nephron formation continues even after birth in preterm infants.

Normally, fetal kidneys are visualized as oval, hyperechoic structures lateral to the upper lumbar spine at around 13-14 weeks of gestation. Following the production of urine, the fetal urinary bladder can also be demonstrated. Due to the cyclical pattern of filling up of the urinary bladder of the fetus and voiding, the bladder has to be visualized at least once during an entire 20 min scan during the second-trimester anomalies scan.[6] The kidneys are more echogenic than the liver and pancreas until 17–18 weeks of gestation. Beyond 20 weeks of gestation, there is decrease in the echogenicity, along with appearance of corticomedullary differentiation, the differentiation being more marked after 28 weeks. Even though there is a gradual increase in the kidney size,[7] the ratio of the renal and abdominal circumferences remains constant which is approximately 0.27–0.30. Usually, renal calyces, ureters, and the urethra are not sonographically visualized under normal circumstances.

Transvaginal sonography has also been recommended as a useful technique to demonstrate the fetal kidneys, particularly during the early weeks of gestation.[8]

US is considered abnormal when the following features are encountered: AP diameter of the renal pelvis over 7 mm (when the fetal bladder is empty), variable dilatation patterns, dilated calyceal system, dilatation of ureter more than 3 mm, thickened pelvic wall, megacystis, loss of renal corticomedullary differentiation, contracted kidney, features of renal dysplasia, decreased amount of amniotic fluid, and pulmonary hypoplasia.[9] According to a recent study, if the urinary tract appears normal in at least two serial ultrasonograms, one during the 1st and another at the 6th week in the postnatal period, there is usually no demonstrable abnormality in voiding cystourethrogram (VCUG).[10]

Apart from routine ultrasonogram, in our institution, VCUG or micturating cystourethrogram and intravenous urogram (IVU) were done for assessing the excretory function and level of obstruction as indicated in patients in whom prenatal imaging has shown evidence of abnormality in urinary collecting system.[11] It has been recommended that VCUG should be done only when postnatal renal sonographic findings are abnormal.

Many etiologies have been attributed to neonatal UTD which includes structural pathology and reflux-related abnormalities. Some of the commonly reported structural and non-structural causes of fetal hydronephrosis in newborns and infants, majority of which includes physiological hydronephrosis as in extrarenal pelvis and transient hydronephrosis, pelviureteric junction obstruction (PUJO), vesicoureteral reflux (VUR), PUV megaureter, megacystis, ureterocele, multicystic kidney disease, and duplex moiety. Identification of non-significant fetal hydronephrosis is clinically important so as to decide the appropriate timing of investigations. When physiological and transient causes are excluded, PUJO and VUR are the major urinary tract abnormalities which require further imaging workup and surgical intervention.[12]

Appropriate timing of postnatal evaluation depends on abnormality which is likely to be associated with pyelectasis. In general, when there is an urgent need for immediate neonatal investigations as indicated in bilateral gross hydronephrosis, dilated single functioning kidney, PUV, and duplex moiety with obstructive features. In such cases, the VCUG and IVU are performed under antibiotic coverage. In neonates with mild to moderate dilation, imaging is ideally done after 4 weeks as there is possibility of spontaneous resolution within 2 to 3 weeks. Prophylactic

Table 1: Normal values for urinary tract dilatation (adopted from multidisciplinary consensus on the classification of prenatal and postnatal urinary tract dilatation, Journal of Pediatric Urology [2014] 10, 982–989)

Ultrasound findings	Time at presentation		
	16–27 weeks	>28 weeks	Postnatal (>48 h)
Anteroposterior renal pelvis diameter	<4 mm	<7 mm	<10 mm
Calyceal dilatation			
Central	No	No	No
Peripheral	No	No	No
Parenchymal thickness	Normal (subjective)	Normal (subjective)	Normal (subjective)
Parenchymal appearance	Normal (echoes/CMD/cortical cyst)	Normal (echoes/CMD/cortical cyst)	Normal (echoes/CMD/cortical cyst)
Ureter	Normal (dilatation)	Normal (dilatation)	Normal (dilatation)
Bladder	Normal(wall thickness/ureterocele/ posterior urethra dilatation)	Normal (wall thickness/ureterocele/ posterior urethra dilatation)	Normal (wall thickness/ureterocele/ posterior urethra dilatation)
Oligohydramnios	No	No	NA

CMD: Corticomedullary differentiation, NA - Not applicable

Table 2: UTD risk stratification: Prenatal presentation for UTD A1 (low risk) and UTD A2–3 (increased risk). (Adopted from multidisciplinary consensus on the classification of prenatal and postnatal UTD, Journal of Pediatric Urology [2014] 10, 982–989)

Prenatal presentation			
16–27 weeks	>28 weeks	16–27 weeks	>28 weeks
APRPD 4–7 mm	APRPD >7 mm	APRPD >7 mm	APRPD >10 mm
Central or no calyceal dilatation		Peripheral calyceal dilatation	
Parenchymal thickness normal		Parenchyma thickness abnormal	
Parenchymal appearance normal		Parenchyma appearance abnormal	
Ureters normal		Ureters abnormal	
Bladder normal		Bladder abnormal	
No unexplained oligohydramnios		Unexplained oligohydramnios	
UTD A1		UTD A2–3	
Low risk		Increased risk	

UTD: Urinary tract dilatation, APRPD: Anteroposterior renal pelvis diameter

antibiotics are used based on the clinical symptoms. In our institution, antibiotics were given only when VUR was demonstrated.

The possibility that a neonate will have significant postnatal renal abnormality is proportional to the severity of the antenatal hydronephrosis. In fact, the third-trimester imaging features usually predict the severity better. Although no direct relationship could be established between extent of dilatation and functioning of the kidney, assessment of the degree of dilation is primarily used as the main parameter. Features of hyperechoic renal parenchyma with the presence of cortical cysts are indicative of renal obstructive dysplasia and probabilities of deteriorating renal function.[13] Based on the degree of antenatal hydronephrosis we can identify the possible etiology . Marked hydronephrosis is suggestive of Pujo which accounts for 10 percent of the cases with fetal hydronephrosis. 50 percent of those with mild hydronephrosis are identified to have transient hydronephrosis and physiological hydronephrosis. 20 percent of the those with mild dilation have extrarenal pelvis and 15 percent of them have VUR. About 80% of cases resolve spontaneously of the second-trimester pyelectasis is seen in either *in utero* or during the 1st year of life.[14] Since majority of antenatally detected uropathies have shown the potential to resolve spontaneously, surgery is performed only after a period of observation. Nowadays, only 5–10% of cases require surgical intervention. Surgical indications are often correlated with the progression of dilatation *in utero* on sequential examinations. Only 10–30% of fetal pyelectasis in reported series proves to be related to VUR postnatally.[15]

Aim

This study aims to study the imaging features of infants with antenatally diagnosed renal abnormalities to form guidelines for the management of these infants and to standardize the parameters related to fetal UTD based on the recommendations given by the multidisciplinary consensus group held in Linthicum, Maryland, USA, in March 2014.

MATERIALS AND METHODS

This prospective study was conducted in the Department of Radiodiagnosis and Pediatric Surgery and Urology, Coimbatore Medical College and Hospital from August 2013 to January 2015.

Demographic, clinical, and laboratory data of all consecutive mothers whose antenatal scans showed sonographic renal abnormalities were prospectively collected for this study. Based on antenatal sonogram findings, three categories were formed based on the extent of UTD. The infants were then evaluated in the postnatal period both clinically in the department of pediatric surgery and with ultrasound in the department of radiodiagnosis, respectively, and classified into two risk groups. Infants in each group were evaluated on a specific set of investigations particular for that group. (The classification into various risk groups is based on the consensus conference held in Linthicum). All the infants were managed according to their postnatal diagnosis and followed up for a period of 1 year. The data collected were evaluated and the results were analyzed to form purposeful guidelines that could help in postnatal management of infants with antenatally diagnosed renal abnormalities.

Exclusion Criteria

Mothers who had antenatal scan elsewhere and came for postnatal follow-up were excluded from the study. Antenatal sonograms with multiple anomalies, chromosomal anomalies, and genitourinary anomalies other than UTD such as ectopic kidneys, ovarian cyst, and Mullerian structure abnormalities were excluded from the study.

Description of Risk Stratification

The risk stratification that we used in our study was proposed by a multidisciplinary consensus group that constituted experts from eight societies with special interest in the management of fetus and infants with UTD.[1] The normal antenatal and postnatal sonographic values are given in Table 1. The AP renal pelvis diameter (APRPD) was measured in transverse plane with spine at 12'O clock position and calipers at widest portion of intrarenal pelvis. The APRPD was graded as mild (4–7 mm), moderate (7-10 mm), and severe (>10 mm) for gestational age between 16 and 27 weeks. For >28 weeks, grading is mild (7–10 mm), moderate (10–15 mm), and severe (>15 mm). Based on antenatal findings, two risk groups are formed, namely, UTD A1 and UTD A2–3, as shown in Table 2. The classification is based on the presence of the most concerning feature.

Similarly, postnatal presentation is divided into three risk groups, namely, UTD P1 – low risk, UTD P2 – intermediate risk, and UTD P3 – high risk, as shown in Table 3.

RESULTS

The number of mothers enrolled in the study between August 2014 and January 2016 was 72. All these mothers had two antenatal scans one in the second trimester (16-27 weeks) and another in the third trimester (>28 weeks). The risk stratification was applied to both the trimester scans and any progression in severity between the 2nd and 3rd trimester were noted. Of the 72 cases, 6 were excluded due to anomalies other than UTD listed in Table 4 and 42 cases had high-risk dilatation UTD A2–3. Twenty-four cases had low-risk dilatation UTD A1.

Among the 24 cases of UTD A1, three cases had low-risk dilatation only in the first trimester and became normal in the second-trimester scan. Six cases who had UTD A1 in both the first and second trimester also had normal postnatal scans at the 1st week of life and at 1 month and are under observation. Among the eight children with UTD P1, six had transient hydronephrosis and two had partial PUJO which was managed conservatively with regular follow-up.

Six neonates had UTD P1 low-risk dilatation, of which three had transient hydronephrosis which resolved and three had partial PUJO which were kept under observation. Among the 14 cases with UTD P2 intermediate-risk dilatation, 11 had complete PUJO, one had partial PUJO, one had bilateral VUR, and one had PUV which were managed as required. In the high-risk group UTD A2–3, there were 42 cases. Six neonates had UTD P1 low-risk dilatation, of which three had transient hydronephrosis which resolved and three had partial PUJO which were kept under observation. Among the 14 cases with UTD P2 intermediate-risk dilatation, 11 had complete PUJO,

Table 3: UTD risk stratification: Postnatal presentation for UTD P1 low risk, UTD P2 intermediate risk, and UTD P3 high risk. (Adopted from multidisciplinary consensus on the classification of prenatal and postnatal UTD, Journal of Pediatric Urology [2014] 10, 982–989)

Postnatal presentation		
APRPD	**APRPD**	**APRPD**
10–15 mm	**>15 mm**	**>15 mm**
Central calyceal dilatation	Peripheral calyceal dilatation	Peripheral calyceal dilatation
Parenchymal thickness normal	Parenchymal thickness normal	Parenchymal thickness abnormal
Parenchymal appearance normal	Parenchymal appearance normal	Parenchymal appearance abnormal
Ureters normal	Ureters abnormal	Ureters abnormal
Bladder normal	Bladder normal	Bladder abnormal
UTD P1	UTD P2	UTD P3

UTD: Urinary tract dilatation, APRPD: Anteroposterior renal pelvis diameter

one had partial PUJO, one had bilateral VUR, and one had PUV which were managed as required.

Twenty neonates with UTD P3 high-risk dilatation were the group that required earlier intervention. It included 10 cases of PUV, six cases of PUJO, one case of obstructive megaureter, one case of VUR, one case of bilateral ureterocele, and one case of non-neurogenic bladder. In this group, 19 cases required surgical intervention [Table 5].

Table 4: Number of patients in each risk group

Category	Number of patients
Total number of antenatal patients	72
Patients with UTD A1 low risk	24
Patients with UTD A2–3 high risk	42
Number of cases excluded	06
Ectopic kidney (2)	
Multicystic kidney disease (1)	
Horseshoe kidney (1)	
Duplex system (1)	
Extrarenal pelvis (1)	

DISCUSSION

Fetal urologic abnormalities encompass a spectrum of disease processes that present a challenge for both the pediatric urologist and obstetrician. Knowledge of the specific conditions will help with prenatal counseling, determination of the need for therapeutic intervention *in utero* versus early delivery, postnatal evaluation, and management of these conditions. Prenatal diagnosis of renal abnormalities opens new and exciting vistas in postnatal management and benefits of fetal ultrasonography (USG) are increasingly evident.

Among the 24 cases of UTD A1, three cases had low-risk dilatation only in the first trimester and became normal in the second-trimester scan.[16] These cases were subjected

Table 5: Evaluation of antenatal high-risk group UTD A2–3

Antenatal risk stratification (>28 weeks)	Postnatal risk stratification	Number of patients	Postnatal evaluation	Final diagnosis	Management
UTD A2–3	Normal	2	Only USG at 1 week	Normal	Observation
UTD A2–3	UTD P1	3	Only USG at 1 week and 1 month	Transient hydronephrosis which disappeared	Observation
		3	USG, MCU, DTPA	Partial PUJO	Observation
UTD A2–3	UTD P2	1	Only USG at 1 week and 1 month	Partial PUJO	Observation
		11	USG, MCU, DTPA	Complete PUJO	Pyeloplasty
		1	USG, MCU, DMSA	Bilateral Grade 2 vesicoureteric reflux	Observation
		1	USG, MCU, DMSA, UDS	PUV	Fulguration
UTD A2–3	UTD P3	10	USG, MCU, DMSA, UDS	PUV	Fulguration
		6	USG, MCU, DTPA	Complete PUJO	Pyeloplasty
		1	USG, MCU, DTPA	Obstructive megaureter	Ureterostomy
		1	USG, MCU, DMSA	Vesicoureteric reflux	Observation
		1	USG, MCU, MRI spine, DMSA, UDS	Non neurogenic bladder	Bilateral ureterostomy
		1	USG, MCU	Bilateral ureterocele	Ureterocele deroofing

UTD: Urinary tract dilatation, MCU: Micturating cystourethrogram, DTPA: Diethylenetriaminopentaacetic acid, DMSA: Dimercaptosuccinic acid, PUJO: Pelviureteric junction obstruction, MRI: Magnetic resonance imaging, USG: Ultrasonography

Table 6: Evaluation of antenatal low-risk dilatation UTD A1

Antenatal risk stratification		Postnatal risk stratification	Number of patients	Postnatal evaluation	Final diagnosis	Management
2nd trimester	3rd trimester					
UTD A1	Normal	Normal	3	Only USG at 1 week	Normal	Observation
UTD A1	UTD A1	Normal	6	Only USG at 1 week and 1 month	Normal	Observation
UTD A1	UTD A1	UTD P1	6	Serial USG	Transient hydronephrosis which disappeared	Observation
			2	USG, MCU, DTPA	Partial PUJO	Observation
			1	USG, MCU, DMSA	Bilateral Grade 2 vesicoureteric reflux	Observation
UTD A1	UTD A1	UTD P2	1	USG, MCU, DMSA, UDS	PUV	Fulguration
			3	USG, MCU, DTPA	Partial PUJO	Observation
			1	USG, DTPA	Complete PUJO	Pyeloplasty
UTD A1	UTD A1	UTD P3	1	USG, DTPA	Complete PUJO	Pyeloplasty

UTD: Urinary tract dilatation, MCU: Micturating cystourethrogram, DTPA: Diethylenetriaminopentaacetic acid, DMSA: Dimercaptosuccinic acid, PUJO: Pelviureteric junction obstruction, USG: Ultrasonography

to only one ultrasound scan in the postnatal period after 1 week of life and all three had normal scans. These three children do not need any further evaluation and are under follow-up.[17] Six cases who had UTD A1 in both the first and second trimester also had normal postnatal scans at the 1st week of life and at 1 month and are under observation.

Out of five children with UTD P2, one had bilateral VUR, three had partial PUJO, and one had complete PUJO which required surgery and the rest needed only observation. Only one case had UTD P3 and that patient was diagnosed with PUJO and managed with pyeloplasty.[18] In the high-risk group UTD A2–3, there were 42 cases. Two fetuses had progressive UTD from UTD A1 in the second trimester to UTD A2–3 in the third trimester. Among the 42 cases, two neonates had normal postnatal scan that was followed up with a USG at 1 month. Six neonates had UTD P1 low-risk dilatation, of which three had transient hydronephrosis which resolved and three had partial PUJO which were kept under observation. Among the 14 cases with UTD P2 intermediate-risk dilatation, 11 had complete PUJO, one had partial PUJO, one had bilateral VUR, and one had PUV which were managed as required [Table 6].[19]

Twenty neonates with UTD P3 high-risk dilatation were the group that required earlier intervention. It included 10 cases of PUV, six cases of complete PUJO, one case of obstructive megaureter, one case of VUR,[20] one case of bilateral ureterocele, and one case of non-neurogenic bladder. In this group, 19 cases required surgical intervention.

CONCLUSION

Antenatally diagnosed renal abnormalities are frequently encountered and there is no proper protocol in postnatal therapeutic management of these conditions. Postnatal management of these infants should be determined before birth.

Evaluating every child with prenatal sonogram renal abnormalities results in the cost-related burden on the health-care resources. Not evaluating any child with prenatal sonogram renal abnormalities could avoid these initial costs but might delay the diagnosis of significant uropathies such as PUV and, consequently, incur higher long-term health and financial costs. The ultimate purpose of the study is to avoid two risks to avoid unnecessary, prolonged postnatal follow-up and delayed diagnosis.

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