Antenatal Hydronephrosis

Antenatal Hidronefroz

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ABSTRACT

The widespread use of ultrasonography during pregnancy has resulted in a higher detection rate for antenatal hydronephrosis. This is one of the most common birth defects detected (1-3%). The most common causes of antenatal hydronephrosis are transient hydronephrosis, ureteropelvic junction obstruction, and vesicoureteral reflux. It can be detected as early as the 12th to 14th week of gestation and in addition, ultrasonography performed in the third trimester (28 to 34 weeks gestation) has been suggested to be more helpful in predicting postnatal outcome. The Society of Fetal Urology grading and renal pelvic diameter grading systems have been developed to diagnose and grade the severity of antenatal hydronephrosis. If dilatation is detected, ultrasound should focus on: laterality, severity of hydronephrosis, echogenicity of the kidneys, hydronenephrosis or hydro-ureteronephrosis, bladder volume and bladder emptying, sex of the child and amniotic fluid volume. They are helpful in determining the cause of hydronephrosis. To date, the reported long-term outcomes of antenatal intervention for severe obstructive uropathy are mixed. The goal of prenatal management is to detect those cases, which will impact the health of the infant and require antenatal and postnatal evaluation and possible intervention to minimize adverse outcomes. Postnatal evaluation includes physical examination and the use of radiologic studies to determine the cause of hydronephrosis and then treatment should focus on this. The main goal of this review is to evaluate and summarize the antenatal hydronephrosis. *(JAREM 2013; 3: 60-5)*

Key Words: Hydronephrosis, infant, newborn, prenatal diagnosis, ultrasonography

ÖZET

Gebelikte ultrasonografi kullanımının artması ile birlikte antenatal hidronefroz tanı oranı da artmaktadır. Antenatal hidronefroz %1-3 oranı ile en sık tanı alan doğum anomalilerinden biridir. En sık nedenleri; geçici hidronefroz, üreteropelvik bileşke darlığı ve vezikoüreteral reflü'dür. Gebeliğin 12-14. haftasında tespit edilebilir. Ek olarak üçüncü trimestırda (gebeliğin 28-34. haftaları) yapılan ultrasonografi, doğum sonrası akıbeti öngörmede daha yardımcı olduğu için, önerilmektedir. Tanı ve sınıflandırmada fetal üroloji dernek sınıflaması ve renal pelvis çap sınıflamaları geliştirilmiştir. Eğer dilatasyon saptanırsa ultrasonda bakılması gereken ek bulgular şunlardır: hidronefrozun tarafı ve derecesi, böbreklerin ekojenitesi, hidroüreteronefroz varlığı, mesane hacmi ve boşalması, cinsiyet ve amniyotik sıvı hacmi. Bu bulgular hidronefroz sebebini tespit etmede faydalıdır. Ciddi obstrüktif üropati için doğum öncesi müdahalenin bildirilen uzun dönem sonuçları çelişkilidir. Doğum öncesi taramanın amacı, bebek sağlığını etkileyebilecek, doğum öncesi ve doğum sonrası değerlendirme ve olası müdahale gerektiren vakaları tespit etmek ve olumsuz sonuçları en aza indirmektir. Doğum sonrası değerlendirmede fizik muayene ve radyolojik tetkikler ile hidronefrozun nedeni araştırılır. Daha sonraki tedavi ise tespit edilen nedene yönelik yapılır. Bu derlemenin amacı antenatal hidronefroz'u gözden geçirmek ve özetlemektir. *(JAREM 2013; 3: 60-5)*

Anahtar Sözcükler: Hidronefroz, bebek, yenidoğan, prenatal tanı, ultrasonografi

INTRODUCTION

The widespread use of ultrasonography during pregnancy has resulted in a higher detection rate for antenatal hydronephrosis (ANH). ANH is dilatation of the renal pelvis with or without dilation of the renal calyces and is identified in 1% to 3% of all pregnancies and is one of the most common birth defects detected (1). It occurs approximately twice as often in malesas in females and is bilateral in 20-40% of cases (2). It can be detected as early as the 12th to 14th week of gestation (3).

The fact that obstruction develops at the same time that the kidney is in the process of formation creates an entirely different paradigm for congenital urinary obstruction as compared with obstruction of the mature kidney. The goal of prenatal management is to detect those cases of ANH that will impact the health of the infant and require antenatal and postnatal evaluation and possible intervention to minimize adverse outcomes.

Etiology

Antenatal hydronephrosis may develop secondary to transient dilation of the collecting system, upper/lower urinary tract obstructive uropathy, and non-obstructive processes such as vesicoureteral reflux (VUR), megaureters, and prune belly syndrome. The most common causes are transient hydronephrosis, ureteropelvic junction obstruction (UPJO), and VUR. Transient hydronephrosis is seen in 41 to 88 percent of cases and may be related to a transient narrowing of the ureteropelvic junction. In a meta-analysis, postnatal evaluation identified a cause in 36% of patients, which were primarily renal/urinary tract abnormalities. UPJO is the leading cause (40%) of hydronephrotic kidneys and increases in frequency with the severity of hydronephrosis. VUR is the second most common diagnosis and was not associated with the severity of hydronephrosis (4).

Other less common causes of ANH include; megaureter, multicystic dysplastic kidney, ureterocele, posterior urethral valves, ectopic ureter, prune belly syndrome, urachal cyst, duplex collecting system, urethral atresia.

Grading

Several systems have been developed to diagnose and grade the severity of ANH.

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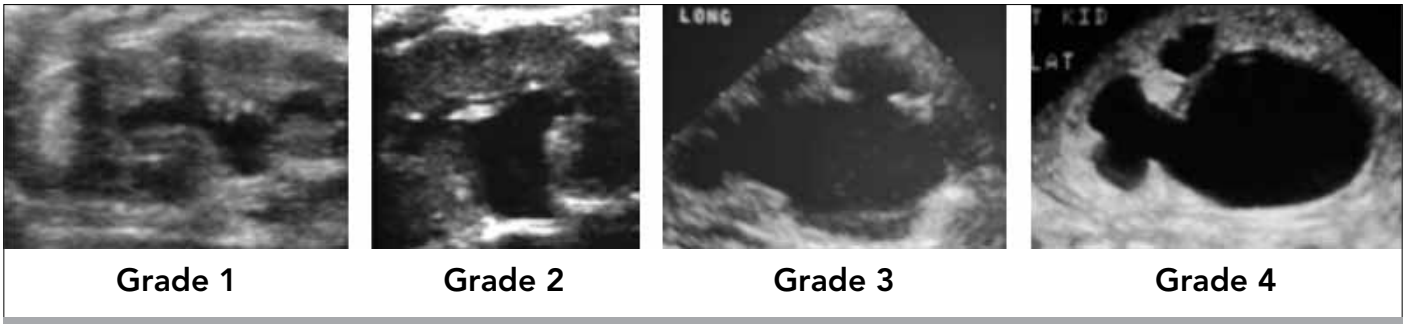

Figure 1. Society of Fetal Urology grading system for hydronephrosis

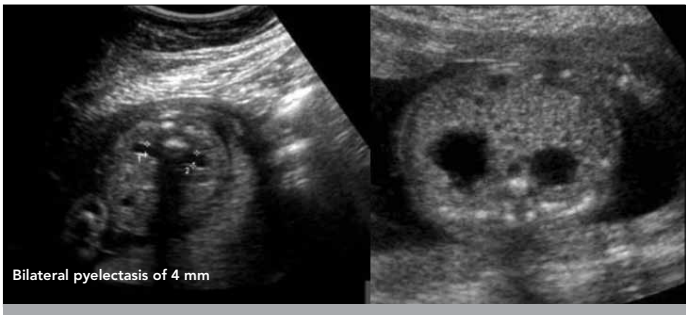

Figure 2. Bilateral mild and severe hydronephrosis

- **Society of Fetal Urology (SFU)** - based upon the degree of pelvic dilatation, number of calyces seen, and the presence and severity of parenchymal atrophy (Figure 1) (5).
  - ❖ Grade 0 - Normal examination with no dilatation of the renal pelvis
  - ❖ Grade 1 - Mild dilatation of the renal pelvis only
  - ❖ Grade II - Moderate dilatation of the renal pelvis including a few calyces
  - ❖ Grade III - Dilatation of the renal pelvis with visualization of all the calyces, which are uniformly dilated, and normal renal parenchyma
  - ❖ Grade IV - Similar appearance of the renal pelvis and calyces as Grade III plus thinning of the renal parenchyma
- **Renal pelvic diameter (RPD)** - Measurement of the maximum anteroposterior diameter of the renal pelvis in the transverse plane (APD) is the most generally accepted method to define ANH (6). There is no consensus on the optimal RPD threshold for determining the need for postnatal follow up. Lower cutoffs will be more sensitive in detecting postnatal pathology; however, the trade off is in higher false positive rates. Most authors use a value above 4 to 5 mm as the lowest cutoff for ANH in the second trimester (Table 1, Figure 2) (7).

Table 1. Definition of ANH by anterior posterior diameter

DEGREE	Anteroposterior Diameter	
	Second Trimester	Third Trimester
Mild	4 to <7 mm	4 to <9 mm
Moderate	7 to ≤10 mm	9 to ≤15 mm
Severe	>10 mm	>15 mm

Table 2. Severity of ANH and the risk of pathology and surgery

	Risk of renal/ urinary tract pathology	Surgical intervention
Mild hydronephrosis	12%	10%
Moderate hydronephrosis	45%	25%
Severe hydronephrosis	88%	68%

Predictive factors

The likelihood that a patient will have significant postnatal congenital anomalies of the kidney and urinary tract (CAKUT) increases with the severity of ANH. A meta-analysis and a study showed that the severity of ANH increased the risk of renal/urinary tract pathology and surgical intervention as follows (Table 2) (4, 8). Compared with an APD of 10 mm, an APD cutoff of 5, 8, and 10 mm during the second, early third, and late third trimesters, respectively, is more specific in predicting the need for postnatal surgical intervention (9).

Ultrasound Examination

Timing of prenatal ultrasonography is important for optimal detection of CAKUT. Ultrasonography performed before the 18 to 24th week of gestation may fail to detect significant disease. In addition, ultrasonography performed in the third trimester has been suggested to be more helpful in predicting postnatal outcome than screening earlier in the pregnancy (10). Thus a repeat scan in the third trimester (28 to 34 weeks gestation) should be performed to identify those fetuses potentially requiring postnatal intervention. A study of 280 infants who had two prenatal ultrasound examinations and a complete postnatal urological evaluation showed that additional prenatal screening changes may be useful in predicting postnatal outcome (11).

- Complete resolution with normal RPD on second ultrasound: 2% required surgery
- Reduced dilatation but not complete resolution on second scan: 3% required surgery
- No change on second scan: 8% required surgery
- Increased dilatation on second scan: 24% required surgery

Table 3. Parameters of prenatal ultrasonographic diagnosis

Parameter	Possible Causes
Hydronephrosis, Caliectasis, Increased pelvic anteroposterior diameter	Obstruction, reflux
Renal parenchyma	Increased echogenicity in dysplasia, obstruction, ARPKD
Urothelial thickening	Variable dilation as with reflux or occasionally obstruction
Duplication	Possible associated reflux or obstruction; look for dilated ureter and ureterocele
Cystic structures, renal	MCDK, ADPKD
Cystic structures, intravesical	Ureterocele
Urinoma	Obstruction
Bladder wall thickness	Obstruction, neurogenic dysfunction
Keyhole sign	Posterior urethral valves
Oligohydramnios	Poor urine output because of obstruction and/or renal failure

ADPKD: autosomal dominant polycystic kidney disease, ARPKD: autosomal recessive polycystic kidney disease, MCDK: multicystic dysplastic kidney

If dilatation is detected, ultrasound should focus on: laterality, severity of hydronephrosis, echogenicity of the kidneys, hidronephrosis or hydro-ureteronephrosis, bladder volume and bladder emptying, sex of the child and amniotic fluid volume. They are helpful in determining the cause of hydronephrosis (Table 3) (7).

Wang et al. (12) showed that disruption of the Robo2 gene is associated with VUR in humans and ANH in knockout mice. They found that hydronephrosis progressed continuously after birth with no spontaneous resolution. Further studies are needed for new serum or urine biomarkers that show the renal damage and spontaneous resolution in ANH.

Antenatal Management

The counseling urologist should provide reassurance and dispel misconceptions, a reasonable differential diagnosis, information of the natural history of the disease, antenatal recommendations, and a postnatal management plan.

The most widely accepted indicator of salvageable renal function is analysis of fetal urine. When the urinary sodium value is less than 100 mg/dL, urine chloride value is less than 110 mmol/L, and urine osmolarity is less than 200 mOsm/dL, renal function appears to be salvageable with in-utero intervention (13). Guez et al. (14) reported 10 fetuses who underwent multiple urine samplings and in whom severe obstruction reduced sodium and calcium reabsorption. They concluded that fetal urinary chemistries were reasonably predictive of severe but not moderate postnatal renal impairment. The use of fetal urinary β2-microglobulin as an indicator of tubular damage was described. Including this parameter, poor renal outcome has been predicted with a specificity of 83% and sensitivity of 80% (15).

In 1982, Harrison et al. (16) described the initial report of fetal surgery in a 21-week old fetus with bilateral hydroureteronephrosis secondary to posterior urethral valves. More recently, the initial method of decompression with open surgery has largely been replaced by in utero shunt placement. The shunt is placed under ultrasound guidance using a Seldinger technique through a trochar. Catheter placement and open fetal surgery have significant fetal and maternal risks. Experience with fetoscopic/endoscopic valve ablation is currently at the case report and experimental level, and long-term outcomes are unknown. There are no studies to determine whether this method of decompression is adequate in the presence of significant bladder dysfunction.

To date, the reported long-term outcomes of antenatal intervention for severe obstructive uropathy (e.g., posterior urethral valves, prune-belly syndrome, urethral atresia) are mixed. A large systematic review of the prenatal intervention for obstructive uropathy showed a statistically significant perinatal survival advantage with shunting (17). Of the studies that have reported long-term outcomes of in utero vesicoamniotic shunting, many of the children have renal insufficiency (57%) and growth impairment (86%). Long-term follow-up (5.8 years) of patients who have survived in utero shunting was reported. They noted acceptable renal function in 44%, mild impairment in 22%, and renal failure in 33%. Patients with prune-belly syndrome had the best renal outcome (57%), followed by those with posterior urethral valves (43%), and then urethral atresia (25%) (18).

The need to consider in utero intervention for obstruction is uncommon. Overall, it appears that in utero intervention for the appropriate patient may reduce the risk of neonatal mortality and may potentially improve renal function. More sensitive and specific markers to better identify which fetus will benefit from in-utero shunting need to be defined.

Postnatal Management

Evaluation includes physical examination and the use of radiologic studies to detect renal and urinary tract abnormalities (Figure 3, 4).

- The physical examination of the newborn can detect abnormalities (abdominal mass, palpable bladder, external genital abnormality, single umbilical artery, etc.) that suggest genitourinary abnormalities associated with ANH.
- Radiological studies begin with an ultrasound examination.

Ultrasonography: Since transitory neonatal dehydration lasts about 48 hours after birth, this will underestimate the degree of hydronephrosis, imaging which should be performed following this period of postnatal oliguria. However, in severe cases (bi-

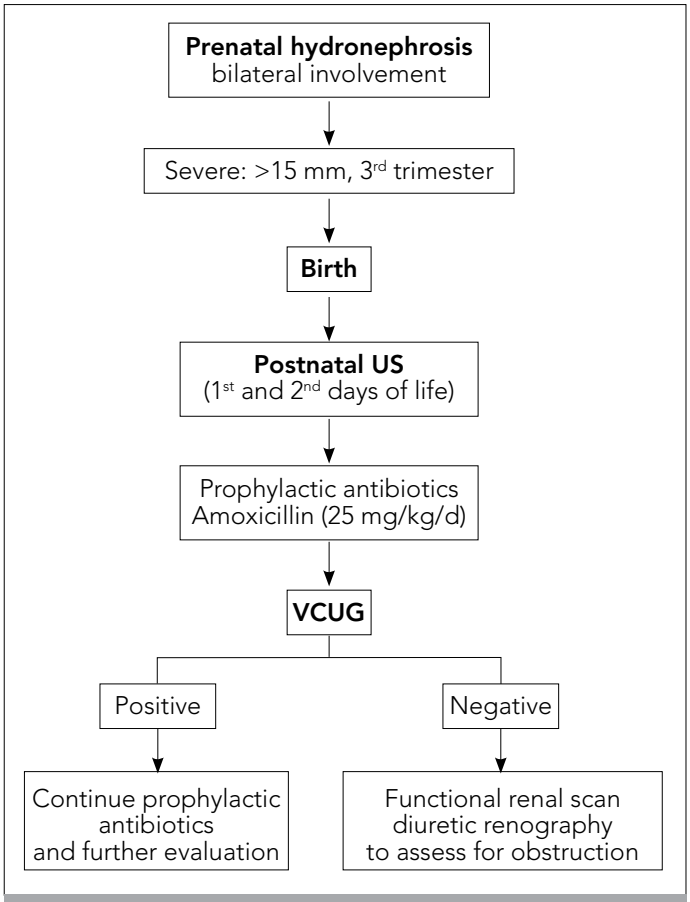

Figure 3. Postnatal evaluation of severe bilateral ANH. If the ANH is mild to moderate (<15mm, 3rd trimester) and there are no other findings suggestive of renal disease, evaluation can be performed after seven days of life

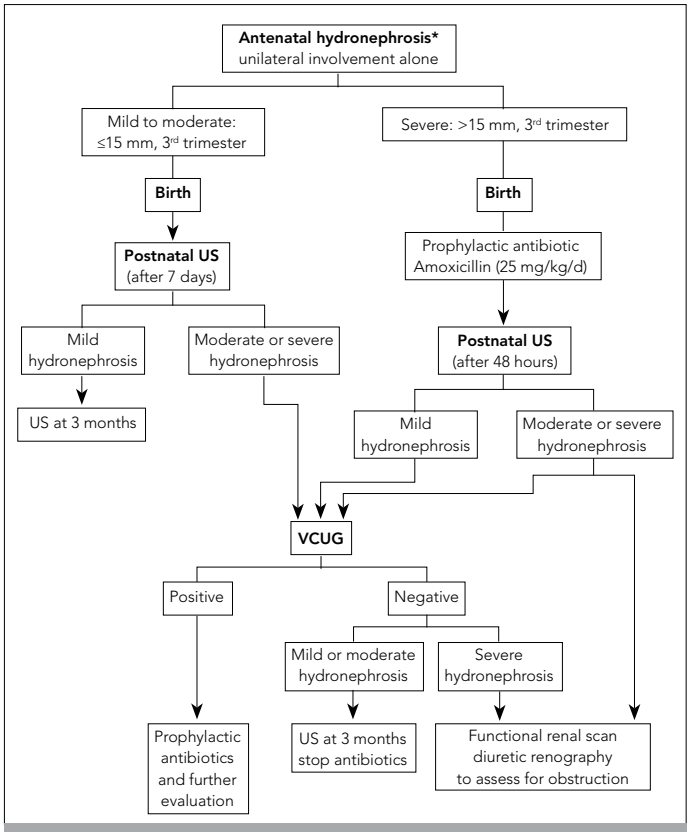

Figure 4. Postnatal evaluation of unilateral ANH. If an ureter, ureterocele, thickened bladder, renal cysts, or renal echogenicity are demonstrated on prenatal ultrasound, evaluation with a postnatal ultrasound should be made before hospital discharge (<48 hours of life)

lateral dilatation, solitary kidney, oligohydramnios), more urgent evaluation is required within 48 hours of birth for a possible need for early intervention.

Voiding cystourethrogram (VCUG): VCUG is performed to detect VUR and in boys to evaluate the posterior urethra. If the VCUG show reflux, infants should remain on antibiotic prophylaxis until the therapeutic options can be discussed with the parents.

Diuretic renography: Renal scan with the administration of a diuretic is the most commonly used diagnostic tool to detect urinary tract obstruction (usually ordered after a VCUG has demonstrated no VUR) and split renal function (19). ^{99m}Tc-MAG3 is the radionuclide of choice. The split renal function is the most useful criteria to evaluate a decrease in renal function. Significant decrease in renal function of one kidney is defined as ≤35% or less and is associated with severe ANH (20). It is important to perform the study under standardised circumstances (hydration, transurethral catheter) between the fourth and sixth weeks of life (21).

Magnetic resonance urography (MRU): MRU in children is becoming more commonly used in the diagnosis and management of congenital uropathies, such as UPJO, because MRU can more clearly define the anatomy and delineate the proper surgical approach (22, 23). The disadvantage of MRU is that the study often requires general anesthesia or heavy conscious sedation in children. Newer MRU technology may even define obstruction, eliminating the need for diuretic renal scans.

The majority of cases with mild or moderate hydronephrosis appear to resolve by 18 months of age. In a prospective study of 282 infants (two months of age) with RPD between 10 and 15 mm, this resolved (defined as RPD ≤5 mm on two consecutive ultrasounds) in 94% of patients by 12 to 14 months of age (24).

A systematic review that included 21 studies showed that, in patients with low-grade hydronephrosis (SFU grades I and II), there was no difference in the rate of UTI between patients treated with continuous antibiotic prophylaxis and those who were not treated (2.2% versus 2.8%). In contrast, patients with high-grade hydronephrosis (SFU grades III and IV) who received continuous antibiotic prophylaxis had a lower rate of UTI compared with those who were not treated with antibiotics (14.6% versus 28.9%) (25).Therefore, we suggest that antibiotic prophylaxis (amoxicillin, 12 to 25 mg/kg/day) is started after delivery in infants with high-grade ANH until the diagnosis of VUR or obstructive uropathy is excluded. In cases confirmed to be UPJO with severe hydronephrosis or with a solitary kidney or bilateral obstructions, antibiotics are continued until surgical correction is performed or there is a decrease in the severity of hydronephrosis. It is important to remember that, prior to the prenatal sonography, UPJO typically presented with urosepsis.

Infants with mild to moderate postnatal hydronephrosis (RPD >7 mm) should have a repeat ultrasound at three months of age. If there is persistent dilation, continue to monitor the degree of hydronephrosis with an ultrasound performed at one year of age. Infants with a normal postnatal examination (defined as a RPD ≤7 mm without calyceal or ureteric dilatation, or signs of renal dysplasia or anomalies) require no further evaluation.

Perhaps the most challenging aspect of managing ANH is determining if and when postnatal surgical correction for obstruction is appropriate. Some have suggested that, regardless of the degree of ANH, moderate or severe postnatal hydronephrosis with evidence of decreased renal function should be an indication for surgical intervention (26). Despite the improved anatomic detail afforded by real-time ultrasonography and the increasing experience with functional nuclear medicine studies, no radiographic or clinical gold standard for physiologically significant obstruction exists.

The debate over the appropriate management of infants with unilateral ANH continues and may ultimately be determined by a combination of epidemiologic, radiographic, and new innovative biomarker discoveries. More accurate and reproducible prenatal and postnatal radiographic documentation of the degree of hydronephrosis and function combined with appropriate natural history data are needed to better categorize these infants. Finally, new serum or urine biomarkers indicative of ongoing renal damage will be critical in helping to further define which infants are truly at risk.

Conflict of Interest
No conflict of interest was declared by the authors.

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