Antenatal diagnosis and outcome of congenital anomalies of the kidneys and urinary tract

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Abstract: Background: Ultrasound screening during pregnancy has resulted in increasing recognition of fetal hydronephrosis. Congenital anomalies of the kidney and urinary tract (CAKUT) represent 20% to 30% of all antenatally diagnosed fetal congenital anomalies in developed countries (1), Depending on diagnostic criteria and gestation, the prevalence of antenatally detected hydronephrosis (ANH) ranges from 0.6 to 4.3%. **Objective:** To study the outcome of different types of CAKUT diagnosed during the antenatal period especially hydronephrosis that identified primarily in the 3rd trimester. **Materials and Methods:** This is a prospective study; all fetuses diagnosed antenatally with urinary tract anomalies are studied for prevalence, pattern of distribution during 2nd and 3rd trimesters by ultrasound and followed 6 weeks after delivery. The cases was examined at the Prenatal Diagnosis and Fetal Medicine Department, National Research Centre, Al Hussien Maternity and Bab El Shaareyia Maternity Hospitals, Al Azhar University, Cairo, Egypt, through a period of 18 months, **Results:** Forty one fetuses with urinary tract anomalies from 640 pregnant women were antenatally diagnosed. The most common abnormalities detected were hydronephrosis, polycystic kidney disease and multicystic dysplastic kidney in descending order of frequency. Moderate and severe hydronephrosis needs more investigation and surgical intervention. Male neonates are at a high risk for post natal hydronephrosis. **Conclusions:** Antenatal diagnosis of CAKUT is a helpful tool in immediate postnatal care and help in early identification of patients who need early surgical intervention. In addition, Moderate Hydronephrosis is associated with high risk of postnatal hydronephrosis.

[Yehia A. Wafa, Mazen A. El Zahry, Mahmoud K. Ahmed, Mona K. Farag and Khaled R. Gaber. **Antenatal diagnosis and outcome of congenital anomalies of the kidneys and urinary tract.** *Life Sci J* 2018;15(5):90-94]. ISSN: 1097-8135 (Print) / ISSN: 2372-613X (Online). http://www.lifesciencesite.com. 15. doi:10.7537/marslsj150518.15.

Key Words: Hydronephrosis, multicystic dysplastic kidney, polycystic kidney, urinary tract anomalies, ultrasonography, early neonate.

1. Introduction

Congenital anomalies of the kidney and urinary tract (CAKUT) represent 20% to 30% of all antenatally diagnosed fetal congenital anomalies in developed countries. [1]

The North American Pediatric Renal Trials and Collaborative Studies (NAPRTCS) report indicated that 30% to 50% of cases of end-stage renal disease are related to congenital anomalies of the kidney and the urinary tract. [2] Therefore, it is important to have an early diagnosis and management, to minimize renal damage and to avoid or delay end-stage renal damage.

The prevalence of congenital anomalies of the kidney and the urinary tract as detected during the antenatal period has been reported as being between 0.1% and 0.7%. [3, 5].

Dilatation of the fetal renal pelvis is one of the most commonly detected abnormalities on ultrasound prenatally, and is accounted for 0.6-4.3% during pregnancies [6, 7].

The high rate of consanguinity marriages in Egyptian population [8] compared to the developed countries necessitates recognition of the pattern of these anomalies in order to take the appropriate steps in prevention and management. This study was designed to study the pattern of distribution, and to report the immediate outcome of these anomalies especially hydronephrotic changes that primarily identified in the 3rd trimester.

2. Material and Methods

This is an observational study performed in the Prenatal Diagnosis and Fetal Medicine Department, National Research Centre, Al Hussien Maternity and Bab El Shaareyia Maternity Hospitals, Al Azhar University, Cairo, Egypt. It is done in a period of 18 months.

The study proceeded after the approval of the Medical Ethics Research Committee at the National Research Centre and Al Azhar University.

The ultrasound examination was performed with a convex 3.5 MHz probe P8 Voluson (GE ultrasound machine).

All women diagnosed as having fetal CAKUT were included in the study. A data collection sheet was designed to record maternal demographic data including age and consanguinity. The CAKUT were classified into hydronephrosis, renal parenchymal

malformation, abnormalities of migration and fusion, abnormalities of the collecting system, and abnormalities of the bladder and the urethra. Cases were divided into isolated urinary tract anomalies or urinary tract anomalies in association with other body systems involvement. Cytogenetic studies were done when indicated based on ultrasound finding of soft tissue markers.

The fetal and immediate neonatal outcomes were reported, including intrauterine fetal death (IUFD), NND, and NICU admission.

Parental consanguinity was defined as first or second cousin marriage.

All exams were done by a single operator to ensure uniformity. The kidneys were assessed in axial plane with the fetal spine in dorso-anterior or dorso posterior position to measure the renal pelvis. The renal pelvis was measured as a vertical line at the maximal dilation of the pelvis. The fetal kidneys were also assessed in the sagittal sections to assess the renal calyces. In addition at the time of fetal examination the ureters were examined for visualization and signs of vesico-ureteric reflux. The fetus was subjected to a thorough examination to rule out other anomalies prior to prenatal counseling.

The ultrasound scan was done every 2 to 3weeks till delivery. Then, we followed the cases after delivery for 6 weeks of life (early neonatal life), and compared prenatal U/S with renal outcome.

The recent classifications of antenatal hydronephrosis [10, 11] were used to grade a value of less than 4mm as normal, 4–7mm as mild, 7–10mm as moderate and greater than 10mm was taken as severe hydronephrosis at a gestational age of less than 28 weeks, and after 28 weeks gestations were graded of less than 7 mm was considered normal, 7–9.9 mm is mild dilatation, 10–14.9 mm is moderate hydronephrosis and ≥15 mm were classified as severe hydronephrosis.

On postnatal ultrasound, a left or right renal pelvic AP diameter > 3 mm was considered to indicate the presence of hydronephrosis, and a diameter ≤ 3 mm was considered normal [9].

The Chi-square test for trend was performed to analyze the association between the grade of antenatal APD and the rate of neonatally confirmed hydronephrosis, and the need for additional imaging studies besides ultrasound examination.

3. Results:

During the study period, 41 case of CAKUT were detected out of 640 fetuses. The mean gestational age at the time of antenatal diagnosis was 26 weeks (ranging from 18 to 36 weeks). Maternal and neonatal characteristics of all cases diagnosed antenatally are shown in **Table 1**. The socio-demographic characteristics of the affected fetuses are shown in **Table 2**.

Positive consanguinity was detected in 34.1% (14/41) of the affected fetuses.

Affected male fetuses constituted 60.9% (25/41), and female fetuses constituted 39.1 % (16/41) of cases.

Cases that diagnosed during the 2nd trimester (16-28) weeks were 70.7 % (29/41), where those who diagnosed in the 3rd trimester (28-36) weeks were 29.3% (12/41) **Table 3.**

Table 1: Maternal and neonatal characteristics of cases with urinary tract anomalies

	Range	**Mean±2SD**
Maternal age	16-44 years	29.1±3.6
Neonatal APGAR (1 min)	2.0-10.0	7.5±1.9
Neonatal APGAR (5 min)	4.0-10.0	9.2±1.21

Table 2: Sociodemographic characteristics of cases with fetal urinary tract anomalies

Characteristics	**No (%)**
Consanguinity	
-Positive	34.1% (14/41)
-Negative	65.9% (27/41)
Maternal age: at expected date of delivery	
-Above 35yrs	17.1% (7/41)
-Below 35yrs	82.9% (34/41)

Male fetuses percentage were 60.9% (25/41), while female fetuses represent 39.1% (16/41)

Table 3: Percent of cases depending on timing of appearance of anomalies

	Number of cases	%
2nd trimester (16-28weeks)	(31/41)	75.6 %
3rd trimester (28-37weeks)	24.4% (10/41)	24.4%

Out of 41 fetuses diagnosed with urinary tract anomalies, 78% (32/41) had isolated urinary tract anomalies, while in 22% (9/41) had associated anomalies including cardiovascular, central nervous system, gastro- intestinal, and skeletal, non immune hydrops **Table 4.**

Chromosomal anomalies were detected in three cases diagnosed antenatally by doing fetal karyotype by amniocentesis at 19 weeks gestation. First case diagnosed as trisomy 18 (47XY+18) with association of other ultrasound soft marker including ompaholocele, bilateral choroid plexus cyst, mega-bladder and bilateral hydroureter hydronephrosis. Second case was diagnosed as Turner syndrome (45XO) with associated bilateral cystic hygroma and hydronephrosis in ultrasound, the last case diagnosed Down syndrome (47 XY+21) with soft tissue marker

including short long bone, echogenic bowl, CHD, hydronephrosis.

In this study, we antenatally detected 7 cases of recurrent CAKUT in 6 families as follows: 2 families had recurrent multicystic dysplastic kidney, 4 families had recurrence of autosomal- recessive polycystic kidney disease, and 1 family had recurrent Meckel Gruber syndrome.

Table 5 demonstrates the pattern of distribution and the frequency of different urinary tract anomalies diagnosed antenatally.

The hydronephrotic changes were diagnosed in 43.9% (18/41) fetuses, the left kidney is more likely to be affected than the right and the majority of cases had mild degrees of hydronephrosis;

Table 6 shows the pattern of distribution of hydronephrosis between 2nd and 3rd trimester.

Fetuses with affected hydronephrotic changes were graded into mild hydronephrosis representing 50 % (9/18), moderate degree included 33.3% (6/18), and severe hydronephrosis 16.7% (3/18).

Follow up of 18/41 cases of hydronephrosis:

In 44.4% (8/18) of fetuses were spontaneously resolved, of the mild (5/9) and moderate (3/6) degree hydronephrotic cases resolved spontaneously either during 3rd trimester of pregnancy and/or were not detected by ultrasound postnatally after urination soon after delivery.

In 33.3% (6/18) of the mild (3/9) and moderate (2/6) and severe (1/3) hydronephrosis showed significant improvement after delivery without intervention.

And 22.2% (4/18) of cases needed surgical intervention. Of these two cases required cystoscopy and ureteric stent insertion, one case had cystoscopy and posterior urethral valve resection, and one case had pyeloplasty.

The major proportion of renal anomalies was polycystic kidney disease, accounting 17.1% (7/41) of the total number of CAKUT. This is followed by multicystic dysplastic kidney 12.2% (5/41) and renal agenesis 12.2% (5/41) **(Table 5).**

Neonatal death occurred in 27.5% (22/41) of cases, and 11.25% (9/41) had intrauterine fetal demise, while 18.75% (15/41) terminated their pregnancies. **Table 7.**

Table 4: Types of affected systems associated with renal anomaly

Type of anomaly	**No. 9/41 (%)**
Associated anomaly:	9/ 41(20%)
1. Central nervous system.	3
2. Cardiac defect.	2
3. Gastro intestinal anomaly.	2
4. Skeletal.	3
5. Non immune hydrops.	2

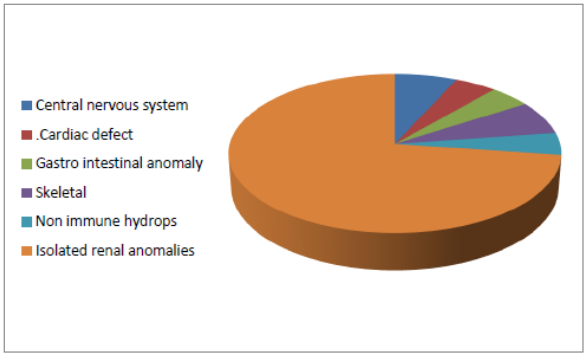

Figure 1: Types of affected systems associated with renal anomaly

Table 5: Types of congenital anomalies of the urinary tract diagnosed antenatally (N=41)

Urinary tract malformation	Cases detected antenatally (%)	Appearance in 3rd trimester after normal 2nd trimester scan	Amniotic fluid volume		
			Increased	Normal	Decreased
Hydronephrosis	43.9% (18/41)	(5/18) Mild (2/5) Moderate (2/5) Severe (1/5)	16.7% (3/18)	61.1% (11/18)	22.2 % (4/18)
Polycystic kidney disease	17.1% (7/41)	-----	42.9% (3/7)	57.1% (4/7)	----
Multicystic dysplastic kidney Unilateral Bilateral	12.2% (5/41) 1 4	------- 1 2	20% unilateral (1/5)	60% bilateral (3/5)	20% bilateral (1/5)
Renal agenesis Unilateral Bilateral	12.2% (5/41) 0 5	----	------ ----- -----	----- ------ ------	100% (5/5) 100%(5/5)
Posterior urethral valve with hydronephrosis	9.8% (4/41)	1	------	25% (1/4)	75% (3/4)
Hyperechogenic kidney	4.9% (2/41)	1	----	100% (2/2)	-----
Total	41	10			

Table 6: Distribution of cases of hydronephrosis between 2nd and 3rd trimester

(n) 18 cases	2nd trimester N (13)	3rd trimester N (5)	Total (%)
Mild (9/18)	7/18	2/18	9/18(50%)
Moderate (6/18)	4/18	2/18	6/18(33.3%)
Severe (3/18)	2/18	1/18	3/18(16.7%)
Total	13/18	5/18	18

Table 7: Perinatal outcome of the cases of urinary tract Anomalies

Intrauterine fetal demise (N/%)	Termination of pregnancy (N/%)	Neonatal death (N/%)	Living neonates
12.2% (5/41)	7.3% (3/41)	14.6% (6/41)	65.9% (27/41)

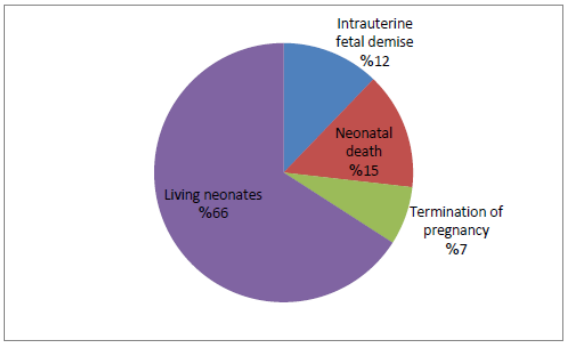

Figure 2: Perinatal outcome of the cases of urinary tract Anomalies

4. Discussion:

In our study affected male fetuses constituted 62.5% (50/80), and female fetuses constituted 37.5 % (30/80) of cases which is close to a study done by **chitra et al 2016** [10].

Positive consanguinity was detected in 35% (28/80) of the affected fetuses. The high rate of consanguinity marriages in Egyptian population compared to the developed countries necessitates recognition of the pattern of these anomalies.

In the multi- center European study done by **Wiesel et al. in 2004** [11] the association of CAKUT and non renal congenital anomalies were seen in about 30% of cases. In our study the percentage of isolated renal anomaly was 62.5%, where +ve past/family history was 15%, and in associated anomalies was 22.5%.

In a meta- analysis by **Lee et al. 2006** [12] that included 17 studies, antenatal hydronephrosis was identified in 1678 fetuses of 104,572 women (1.6%). However, the criteria for the diagnosis of hydronephrosis differed among the included studies. Of all antenatal CAKUT anomalies in the current study, hydronephrosis is the most frequent abnormality seen (61.8%) representing 1.7 per 1000 births, whereas in our study there is 42.5% (34/80) of cases were diagnosed as hydronephrosis with different degrees of mild 27.5% (22/80), moderate 8.75% (7/80), and severe 6.25% (5/80), but majority of mild and moderate hydronephrosis were resolved completely during follow up examination scan.

Many studies have examined outcomes of antenatally diagnosed renal pelvic dilatation. **GЄokaslan et al 2012** [13] reported that the spontaneous resolution of mild hydronephrosis was significantly greater than that of severe hydronephrosis (64% vs. 29%), respectively.

The majority of hydronephrotic cases occurred in male fetuses (66%). This finding is in concordance with that reported by **González et al. 2001.** [14]

Shamshirsaz et al 2012 [15] examined fetal renal pelvic diameters determined by ultrasound with respect to predicting the need for subsequent postnatal surgery and found that a second trimester renal AP diameter of 9.5 mm had a sensitivity of 71% and specificity of 81%, and a third trimester value of 15.0 mm had a sensitivity of 85% and a specificity of 94% for predicting the need for postnatal surgery

In the multi- center European study done by **Wiesel et al**. [16] the association of CAKUT and non- renal congenital anomalies were seen in about 30% of cases. Our data showed the association between renal and non renal is 20%.

Conclusion and Recommendations

Antenatal ultrasound examination should be performed routinely for all pregnant women to diagnose fetal congenital anomalies and help in establishing plans for post natal care to optimize the outcome, and reduce or delay the progress of renal function deterioration. Also the study showed that the grade of antenatal APD was significantly associated with the rate of neonatally confirmed hydronephrosis and the need for additional postnatal imaging studies. Neonates with mild antenatal APD can be discharged early, neonates with moderate and in particular with severe APD need close follow-up. Lastly, male neonates are at high risk for post natal hydronephrosis.

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5/22/2018