Study of Congenital Anomalies of the Kidneys and Urinary Tract in Neonates

Chougule A¹, Purkayastha J², Lewis L³, Aiyappa G⁴, Barche A⁵

Abstract

Introduction: Congenital anomalies of the kidneys and urinary tract (CAKUT) comprise various structural malformations that result from defects in morphogenesis of the kidney and/or urinary tract. In most cases, CAKUT are associated with infant mortality and morbidity in older children and adults. Hence this study was undertaken to follow up antenatally diagnosed cases of CAKUT and see their outcome in the first six months of life.

Material and Methods: An observational follow up study was conducted in the department of Paediatrics in a tertiary care hospital. All inborn neonates, whose antenatal anomaly scans showed the presence of CAKUT were included in the study. Abdominal ultrasound (USG) were done on day three of life for all these neonates and those whose day three USGs showed presence of CAKUT were followed up over a period of six months and outcome was assessed.

Results: CAKUT was more common among males. Hydronephrosis was the most common CAKUT in antenatal scans. Anomalies of the renal collecting system formed 93.9% of all CAKUT detected on antenatal anomaly scan and 57.4% of these resolved by six months of age. Abnormalities of the renal collecting system together formed 93.9% of all antenatally diagnosed CAKUT and were more common than abnormalities of the renal parenchyma which formed 6.1%. Postnatal resolution on day three scan was seen in seven out of 22 (31.8%) cases of antenatally diagnosed mild hydronephrosis irrespective of their site. Out of the 28 antenatally diagnosed hydronephrosis, 11 (39.3%) resolved at some point during the follow up period of six months.

Conclusions: Antenatally diagnosed CAKUT were more common among male foetuses. On day three scan, 29.2% of CAKUT showed resolution. Hydronephrosis remained the most common among male foetuses. On day three scan, 29.2% of CAKUT showed resolution. Hydronephrosis remained the most common and was detected by antenatal scans and was better detected by antenatal scans than anomalies of renal parenchyma.

Key words: antenatal scan; CAKUT; hydronephrosis; neonates

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Introduction

Congenital anomalies of the kidneys and urinary tract (CAKUT) comprise various structural malformations that result from defects in morphogenesis of the kidney and/or urinary tract. These anomalies are the most commonly diagnosed malformations in the antenatal period and constitute 15-20% of antenatally diagnosed congenital anomalies. In most cases, CAKUT may remain asymptomatic, but many types of CAKUT are associated with infant mortality and cause significant morbidity in older children and adults. Antenatal scans done between 16-20 weeks of gestation can pick up renal anomalies and in case of severe anomalies legal termination of pregnancy is possible at this fetal age. 

The most common CAKUT detected antenatally and postnatally is hydronephrosis and the most common cause being transient. Left kidney is more commonly affected. Current literature states that CAKUTs are multifactorial in origin rather than due to single gene mutation. Molecular genetic analysis has shown that renal malformations arise from defects in genes that encode signalling and transcription factors. CAKUT is a major cause of end stage renal disease in young children. Renal impairment affects the growth and development of the affected children. Antenatal diagnosis helps in early intervention and preservation of the renal function. Earlier studies done on antenatal CAKUT do not have meticulous follow up and outcome till six months of age. Our study is unique because the antenatal diagnosis of CAKUT was followed up meticulously till six months of age and their outcome was noted.

Material and Methods

A prospective observational study was carried out at the Department of Paediatrics in a tertiary care hospital in India. Clearance was obtained from Institutional Ethics Committee. The recruitment period was from September 2016 to February 2018 and the follow up period was up to August 2018. All neonates whose antenatal anomaly scans showed presence of CAKUT were included in the study. Neonates who died or were taken DAMA within 48 hours of birth were excluded. Multiple gestations were also excluded. Trans-abdominal ultrasonography was done by a skilled staff member of the Department of Obstetrics and Gynaecology using a Philips EPIQ 5 USG machine with a linear probe of a frequency of 7-12MHz on day three of life for all neonates included in the study. Those neonates whose day three scans showed persistence of CAKUT had repeat scans done between one and three months of age (first follow up scan). Repeat scans were done between three to six months of age for all those infants whose first follow up scans showed persistence of CAKUT.

Outcomes were assessed with the following parameters-Postnatal persistence of antenatally diagnosed CAKUT and persistence during the follow up period of six months, the degree and progression of CAKUT and comparison with previous scans, any surgical intervention, the findings of additional investigations such as MCU, DMSA and DTPA scans, if done, were noted, development of other complications due to CAKUT such as UTI, deranged renal function and outcome at the end of the six months follow up period.

Results

During the recruitment period, 4457 neonates were born at our hospital. Out of these inborn, 70 neonates met the inclusion criteria for our study. Neonates excluded were five. The remaining 65 neonates were included in the study and followed up postnatally. Postnatal resolution of CAKUT was seen in 19 (29.2%) neonates and the remaining 46 (70.8%) showed presence of CAKUT on postnatal day three scan and were followed up further. These 46 were called for follow up between one to three months of age. However, one infant was not brought for follow up, hence follow up USGs were done for 45 infants. The USGs of 13 (28.9%) infants were normal and the remaining 32 were called for follow up. Between three to six months of age, repeat USGs were done for 30 infants.

The USGs of five (16.7%) were normal. Most of the mothers of the neonates included in the study, 47 out of 65 (72.3%), were between 20 to 29 years of age with a mean age of 27.9 (±3.5) years. Most of the neonates included in the study, 36 out of 65 (53.4%), were born to primigravida mothers. The most common mode of delivery (29 out of 65 cases) was by Emergency LSCS (44.6%), with the most common indication being non progression of labor seen in 15 (51.7%) cases and the second most common indication was oligohydramnios seen in six (20.7%) cases. However, only 10.8% cases had associated oligohydramnios. Most of the babies included in the study (52 out of 65, 80%) were born at term with a mean gestational age of 37.4 (±2.4) weeks. Most of the neonates (62 out of 65, 95.4%), were appropriate for gestational age and 53 out of 65 (81.5%) weighed more than 2500 gm with a mean of 2934.9 (±576.2) gm. During our study, it was noticed that antenatally diagnosed CAKUT was more common among male foetuses as compared to female. Out of the 65 neonates included in the study, 48 (73.9%) were males with a male:female ratio of 2.7:1. Other congenital anomalies were seen in three, i.e., 4.61% of neonates included in the study. Out of these three neonates, one had Down syndrome, one of them had pre-auricular skin tags and one had single umbilical artery.
Congenital Anomalies of Kidneys

Fig 1: Study flow chart

Table 1: Types of CAKUT seen on antenatal anomaly scan

| Type of CAKUT seen on antenatal anomaly scan | Number (N=65) | % |
|-------------------------------------------|---------------|---|
| Mild prominence of pelvicalyceal system   | 26            | 40% |
| Hydronephrosis                            | 28            | 43.1% |
| Raised cortical echogenicity               | 1             | 1.5% |
| Pyelactasis                                | 7             | 10.8% |
| Renal cyst                                 | 1             | 1.5% |
| Multicystic dysplastic kidney              | 2             | 3.1% |

Hydronephrosis accounted for the most common antenatally diagnosed CAKUT seen in 28 out of 65 cases (43.1%). Abnormalities of the renal collecting system together formed 93.9% (61 out of 65 cases) of all antenatally diagnosed CAKUT and were more common than abnormalities of the renal parenchyma which formed 6.1%.

Amongst all antenatally diagnosed hydronephrosis, bilateral mild hydronephrosis was the commonest one (53.6%). The neonates with lesser degrees of hydronephrosis had less adverse renal outcome. Postnatal resolution on day three USG was seen in seven out of 22 (31.8%) cases of antenatally diagnosed mild hydronephrosis irrespective of their site. Overall 25% (seven out of 28) of antenatally diagnosed hydronephrosis showed resolution on postnatal day three scan. Severe degree of hydronephrosis was seen in 10.7% cases of hydronephrosis seen in antenatal anomaly scan and 17.6% of hydronephrosis seen on postnatal day three scan. DTPA scan was done for three infants with hydronephrosis at follow up and one infant at three months of age was abnormal. Surgical intervention was required during the neonatal period for three neonates and one at three months of age. It was observed that culture positive UTI was seen more common in infants with moderate and gross degrees of hydronephrosis as compared with other CAKUT. Out of the 28 antenatally diagnosed hydronephrosis, 11 (39.3%) resolved at some point during the follow up period of six months. During our study, five neonates were diagnosed to have multi-cystic dysplastic kidney. Out of these five only two were diagnosed antenatally, and the other three presented as various degrees of hydronephrosis on antenatal anomaly scan. DMSA was done for all five and showed non visualisation of the affected kidney. Out of the 61 neonates whose antenatal anomaly scans showed anomalies of renal collecting system, nine (14.8%) showed worsening, nine (14.8%) showed improvement, 35 (57.4%) resolved, three (4.9%) were lost to follow up and three (4.9%) presented as MCDK and the remaining two (3.2%) remained the same. Gross hydronephrosis was seen in three neonates on day three USG and was persistent at six months of age in spite of surgical intervention.

| Site and degree of hydronephrosis | Number (N=28) | % |
|-----------------------------------|---------------|---|
| Unilateral left-                  |               |   |
| Mild                              | 5             | 17.8% |
| Moderate                          | 5             | 3.6% |
| Severe                            | 2             | 7.1% |
| Unilateral right-                 |               |   |
| Mild                              | 2             | 7.1% |
| Moderate                          | 1             | 3.6% |
| Bilateral hydronephrosis-         |               |   |
| Mild                              | 15            | 53.6% |
| Moderate                          | 1             | 3.6% |
| Severe                            | 1             | 3.6% |

Table 2: Degree and site of fetal hydronephrosis detected antenatally on anomaly scan

**Total number of inborns born during the study period**
N=4457

**Inborns whose antenatal anomaly scans showed CAKUT**
N=70

**Inborns included in the study**
N=65

**Inborns included in the study whose postnatal (Day3) USG showed N=46**

**Infants for whom follow up USG was done between 1 and 3 months of age N=45**

**Infants for whom follow up USG was done between 3 and 6 months of age N=30**

**5 neonates excluded 3 excluded due to multiple gestations 1 went DAMA 1 expired**

**19 resolved antenatally**

**1 lost to follow up**

**13 resolved 2 lost to follow up**

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Hydronephrosis remained the predominant CAKUT at follow up. The persistence of CAKUT postnatally was significantly more among male neonates as compared to female with a male:female ratio of 3.6:1. Out of the 17 cases of hydronephrosis seen postnatally, 14 were males, with a male:female ratio of 7:1. Multi-cystic dysplastic kidney was also more common among males, with a male:female ratio of 4:1.

Table 3: Depicting the outcome of various antenatally diagnosed Hydronephrosis

| Antenatal anomaly scan | Postnatal Day3 scan | Follow up scan done between 1 to 3 months | Follow up scan done between 3 to 6 months |
|------------------------|---------------------|------------------------------------------|------------------------------------------|
| Bilateral mild hydronephrosis (N=15) | Mild prominence of pelvicalyceal system (N=3) | Left sided mild hydronephrosis (N=1) | Resolved (N=1) |
|                         | Resolved (N=5)      | Left sided mild hydronephrosis (N=1)     | Lost to follow up (N=1) |
|                         | Left mild hydronephrosis (N=5) | Left sided mild hydronephrosis (N=3) | Left sided mild hydronephrosis (N=3) |
| Right sided mild hydronephrosis (N=2) | Bilateral moderate hydronephrosis (N=1) | Left sided moderate hydronephrosis (N=1) | Left sided moderate hydronephrosis (N=1) |
|                         | Raised echotexture (N=1) | Bilateral severe hydronephrosis (N=1) | Left sided severe hydronephrosis (N=1) |
|                         | Mild prominence of pelvicalyceal system (N=1) Multicystic dysplastic kidney (N=1) | Left sided severe hydronephrosis (N=1) | Bilateral severe hydronephrosis (N=1) |

Table 4: Depicting the outcome of various antenatally diagnosed hydronephrosis

| Antenatal anomaly scan | Postnatal scan done on Day3 | Follow up scan done at 3 months | Follow up scan done at 6 months |
|------------------------|-----------------------------|--------------------------------|--------------------------------|
| Left sided mild hydronephrosis (N=5) | Bilateral mild hydronephrosis (N=1) | Left sided mild hydronephrosis (N=1) | Left sided mild hydronephrosis (N=1) |
|                         | Left sided severe hydronephrosis (N=1) | Left sided severe hydronephrosis (N=1) | Left sided severe hydronephrosis (N=1) |
|                         | Resolved (N=2) Multicystic dysplastic kidney (N=1) | Multicystic dysplastic kidney (N=1) | Multicystic dysplastic kidney (N=1) |
| Right sided moderate hydronephrosis (N=1) | Bilateral mild hydronephrosis (N=1) | Right sided severe hydronephrosis (N=1) | Right sided severe hydronephrosis (N=1) |
| Left sided moderate hydronephrosis (N=1) | Left sided mild hydronephrosis (N=1) | Resolved (N=1) | Left sided mild hydronephrosis (N=1) |
| Bilateral moderate hydronephrosis (N=1) | Bilateral severe hydronephrosis (N=1) | Bilateral severe hydronephrosis (N=1) | Left sided severe hydronephrosis (N=1) |
| Left sided severe hydronephrosis (N=2) | Left sided severe hydronephrosis (N=1) Multicystic dysplastic kidney (N=1) | Left sided severe hydronephrosis (N=1) Multicystic dysplastic kidney (N=1) | Left sided severe hydronephrosis (N=1) Multicystic dysplastic kidney (N=1) |
| Bilateral severe hydronephrosis (N=1) | Bilateral mild hydronephrosis (N=1) | Left moderate hydronephrosis (N=1) | Left mild hydronephrosis (N=1) |
Discussion

In a similar study by N. S. Bondagji, in Saudi Arabia, where the sample size was 141, the mean maternal age was 29.1 years which was similar to the findings of our study. In our study 10.8% (seven out of 65) cases had associated oligohydramnios. This finding did not match with that of other similar studies where the percentage of associated oligohydramnios was higher. In a similar study by G. R. Karambelkar, carried out at Pune, India, where the sample size was 40, 11 i.e. 27.5% of the cases had associated oligohydramnios. In the study by N.S. Bondagji, the mean gestational age was 37.6 weeks and mean birth weight was 2810 gm and these findings were similar to the findings of our study.

The male preponderance observed amongst antenatally detected CAKUT was persistent postnatally. This was consistent with the results of the study by N.S. Bondagji where 66.7% of the neonates were males. In a study conducted by Choi et al., the prenatal prevalence of CAKUT was more common among males with a male:female ratio of 2.8:1 which was similar to the findings of our study.

Hydronephrosis accounted for the most common antenatally diagnosed CAKUT, seen in 28 out of 65 cases (43.1%) which was consistent with the findings of various other similar studies. Also the observation that abnormalities of the renal collecting system were more common than those of the renal parenchyma was similar to that of various other similar studies.

During our study we observed that antenatally, bilateral mild hydronephrosis was most common (53.6%). However in various other similar studies, it was observed that the left kidney was more often the site for hydronephrosis. On postnatal day three scan, 25% (seven out of 28) of antenatally detected hydronephrosis showed resolution. In the study by G. R. Karambelkar, 10 out of the 11 cases of antenatally diagnosed hydronephrosis continued to persist postnatally.

During our study, the persistence of CAKUT postnatally was significantly more among male neonates as compared to female. This was similar to the findings of the study conducted by H. A. Choi et al., where the male:female ratio was 1.8:1. In our study it was also seen that male infants had a higher incidence of hydronephrosis postnatally which was also seen in the aforementioned study where the male:female ratio was 6.7:1. During our study, multi-cystic dysplastic kidney was also more common among males, with a male:female ratio of 4:1. However in the above mentioned study by H. A. Choi et al., Multicystic Dysplastic Kidney (MCDK) was more common among females with a male:female ratio of 1:3.

It is one of the few studies that includes the follow up of CAKUT up to six months of age. The outcome of various types and degrees of CAKUT were considered. The study group was followed up closely and even minor interventions or investigative procedures done were taken into consideration. During the study, the findings of third trimester scans were not taken into consideration and the chances of inter-observational variability remain.

Conclusion

Antenatally diagnosed CAKUT were more common among male foetuses. On day three scan 29.2% of CAKUT showed resolution. Hydronephrosis remained the most common antenatally as well as postnatally detected CAKUT. Moderate and severe hydronephrosis detected on antenatal scan had complications and some required surgery at followup. Multi-cystic dysplastic kidney (n=5), out of these five cases only two were diagnosed on antenatal scan and all five had poor prognosis. Anomalies of renal collecting system were better detected by antenatal scans (93.9%) than anomalies of renal parenchyma (6.1%).

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