## Fetal Renal Cystic Diseases

by Cathy Clover, Samiya Moura, Fabricio Costa, and Simon Meagher

1 Mercy Hospital for Women, Melbourne University, Australia; 2. Stellenbosch University, South Africa; 3. University of Fortaleza, Brazil; 4. Monash Ultrasound for Women, Melbourne, Australia

### Ultrasound Finding

| Finding | ArPKD: Case 1 | ARPKD: Case 2 | ARPKD: Case 3 | Multicystic Kidney Disease (MCKD): Case 1 | MCKD: Case 2 | Multicystic Kidney Disease (MCKD): Case 3 | Multicystic Kidney Disease (MCKD): Case 4 | Autosomal Dominant Polycystic Kidney Disease (ADPKD): Case 1 | ADPKD: Case 2 | ADPKD: Case 3 | ADPKD: Case 4 | Hydrocephalus: Case 1 | Hydrocephalus: Case 2 | Hydrocephalus: Case 3 | Hydrocephalus: Case 4 | Unexplained Hyperchoeic Kidneys |
|---------|----------------|----------------|----------------|------------------------------------------|-------------|------------------------------------------|------------------------------------------|----------------------------------------------------|-----------------|----------------|----------------|--------------------------------|-----------------|-------------------------------|-------------------------------|-----------------------------|-----------------------------|
| Kidneys | Bilateral, hyperechoic enlarged kidneys from 16w | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys |
| Diagnosis | Oligohydramnios | Oligohydramnios | Oligohydramnios | Oligohydramnios | Oligohydramnios | Oligohydramnios | Oligohydramnios | Oligohydramnios | Oligohydramnios | Oligohydramnios | Oligohydramnios | Oligohydramnios | Oligohydramnios | Oligohydramnios | Oligohydramnios |
| Renal length | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis | Most valuable in diagnosis |
| 1-2 mm non-communicating | | | | | | | | | | | | | | | |
| Renal cysts, some may have macrocystic disease | | | | | | | | | | | | | | | |
| Cystic fusiform dilatation of the collecting ducts | | | | | | | | | | | | | | | |
| Loss of reniform shape | | | | | | | | | | | | | | | |
| Ultrasound findings after 14 weeks | | | | | | | | | | | | | | | |
| US Findings after 24-16 weeks | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys |
| Bilateral, enlarged or grossly enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys | Bilateral, hyperechoic enlarged kidneys |
| Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only | Hyperechoic cortex only |
| Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation | Exaggerated corticomedullary differentiation |
| Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS | Cysts in pancreas, liver, spleen, and CNS |
| No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys | No cysts seen in kidneys |

### Bladder

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<tr>
<th>Abnormal</th>
<th>Normal</th>
<th>Abnormal/Normal/Normal Unexplained</th>
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<tr>
<td>Abnormal</td>
<td>Normal</td>
<td>Abnormal/Normal/Normal Unexplained</td>
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### AFI

| Develop severe oligohydramnios | Normal if unilateral, oligohydramnios if bilateral | Usually normal | Normal or oligohydramnios (dependent on cause) | Normal/reduced | Normal |

### Subtypes

1. **Unilateral ARPKD**
2. **Unilateral ARPKD with an abnormal contralateral kidney**
3. **Unilateral ARPKD in a small solitary kidney**
4. **Unilateral ARPKD with perinephric urinoma**
5. **Unilateral ARPKD with an abnormal contralateral kidney**

6. **Bilateral ARPKD**
7. **Hypervascular ARPKD**
8. **Normal Kidney**

### Normal KIDNEY

- Bilateral, hyperechoic enlarged kidneys from 16w
- Diagnosis only made in 50% at mid trimester
- Renal length most valuable in diagnosis
- 1-2 mm non-communicating
- Renal cysts, some may have macrocystic disease
- Cystic fusiform dilatation of the collecting ducts
- Loss of reniform shape
- Ultrasound findings after 14 weeks

### Normal Kidneys

- Often unilateral (80%)
- Large hyperechoic kidneys
- Multiple and non-communicating cysts of variable shapes and sizes
- Loss of reniform shape
- Ultrasound findings after 14 weeks

### Multicystic Kidney Disease (MCKD)

- Bilateral, hyperechoic enlarged kidneys
- Hyperechoic cortex only
- Exaggerated corticomedullary differentiation
- Cysts in pancreas, liver, spleen, and CNS
- No cysts seen in kidneys

### Autosomal Dominant Polycystic Kidney Disease (ADPKD)

- Bilateral, hyperechoic enlarged kidneys
- Hyperechoic cortex only
- Exaggerated corticomedullary differentiation
- Cysts in pancreas, liver, spleen, and CNS
- No cysts seen in kidneys

### Hydrophrosis

- Caliectasis: connections visible between calyces and pelvis
- Parenchyma not echogenic
- Eggshell sign: crescent of increased echogenicity at caliceal/parenchymal interface
- Unilateral or bilateral
- Associated with megaureter and perinephric urinoma
- Present if renal pelvis AP diameter >5mm at less than 32 weeks and >10mm after 32 weeks

### Hyperchoeic Kidneys

- Echogenic kidneys
- May be enlarged
- Associated with other anomalies

### Unexplained Hyperchoeic Kidneys

- Unilateral or bilateral
- No other anomalies
## Autosomal recessive polycystic kidney disease (ARPKD): Potter I

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<tr>
<td>1-20 000-40 000</td>
<td>Unilateral: 1 300-5 000, Bilateral: 1 10 000</td>
<td>Most common uropathy 1: 100</td>
<td>Sporadic/genetic-linked/Family-linked/age-linked</td>
<td>10-210 000 hyperechoic kidneys</td>
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### Associated anomalies
- Potter sequence develops after 20 weeks (oligohydramnios and pulmonary hypoplasia)
- Liver cysts, hepatic fibrosis, portal hypertension and biliary duct hypoplasia
- In 30%-50 the other kidney is dysplastic or affected by vaso-urinary reflux
- Unilateral: 26% extra-renal anomalies
- Bilateral: 67% extra-renal anomalies
- Extra-renal anomalies: cardiac (majority), GIT, CNS, spine, single umbilical artery, genital anomalies.
- Syndromes: VACTERL, Cerebroadigital, Brachio-oto-renal, Meckel-Gruber, Bardet-Biedel, Fraser, CHARGE

### Genetic anomalies
- Outcomes: management
- Genetic: anomalies and aneuploidies

#### Incidence

- 25%

#### Postnatal: Pre- and postnatal

- Juvenile
  - 4 types:
    - Autosomal recessive anomalies and aneuploidies
      - Gene on chr 6P21
    - Postnatal:
      - Prenatal
        - 32% die in 1st trimester
        - 45% develop hypertension by 1st trimester
        - Involution of cysts occurs
        - May undergo spontaneous resolution
      - Serial ultrasounds to assess liquor volume and contralateral kidney
        - If no family history, tuberous sclerosis
          - Must have postnatal follow up of the contralateral kidney
      - Gross hematuria
        - May undergo spontaneous regression and atrophy
      - Nephrectomy of affected kidney: last resort if recurrent infections, haematuria or severe HPT.
      - Vescoureteral reflux: 1%
      - If no family history, tuberous sclerosis should be excluded
      - Serial ultrasounds to assess liquor volume
      - Renal and paediatric input
        - Refer parents and siblings for renal ultrasound

- Adults
  - 75% for ADPKD
  - Degree of hydronephrosis is significant: AP diameter >6mm in 2nd trimester
  - Postnatal risks greater if >6mm in 2nd and >10 in 3rd trimester
  - Isolated mild pyleostasis doesn't inc risk of aneuploidy
  - Serial US: monitor bladder distension and AFI
  - T: poor prognosis, can offer TOP
  - Degree of hydronephrosis is significant: AP diameter >6mm in 2nd trimester

#### Genetic counselling
- Offer karyotype with microarray
- TOP may be indicated
- Serial ultrasounds to assess liquor volume

#### Outcomes

- 40-50% develop hepatic fibrosis, PHT, portal hypertension
- 30% die in neonatal period
- 55-100% develop hypertension by 15 years of age
- 20-45% have end stage renal disease by 15 years of age
- 11-45% develop portal hypertension
- May need dialysis and renal transplantation

#### Risk factors

- 25%

### Genetic associations/ Aetiology

- Autosomal recessive
  - Significant genetic heterogeneity
  - Single gene disorder: 80% mutation in PKHD1 gene on chr 8p21
  - Can be associated with other single gene anomalies and aneuploidies
  - Types: prenatal, neonatal, infantile and juvenile

#### Genetic: anomalies and aneuploidies

- Risk of chromosomal anomalies in 5-10%
  - 50% non-genetic linked
  - 10% autosomal dominant
  - 30% Monogenic causes: mutations in individual genes, such as TCF2, PAQ2 and uropakins
  - Heterozygote mutations in several genes

- Risk of non-chromosomal syndromes in 5-10%

- Autosomal dominant (90%)
  - 10%: no family history of ADPKD (genetic mutation)
  - PKD1 mutations (85%): gene on chromosome 16p13
  - PKD2 mutations (15%): gene on chromosome 4q21-q23
  - Can be a component of tuberous sclerosis: gene TSC2 on chromosome 16

### Antenatal management

- Genetics referral
- Invasive testing should be offered
- Ideally microarray and specifically request PKHD1 gene on chromosome 8p21 (80% cases)
- Parenteral karyotyping may be indicated
- Discuss prognosis and option for termination pregnancy in early onset disease
- Serial ultrasounds to assess liquor volume
- Renal and paediatric consultation

#### Genetic: anomalies and aneuploidies

- Morphological fetal assessment for other anomalies and syndromes
- Invasive testing is offered if bilateral renal involvement or if associated non-renal abnormality
- Serial US: to check liquor volume and contralateral kidney
- Renal and paediatric consultation
- Refer parents and siblings for renal ultrasound

#### Genetic consultation

- Can offer genetic sequencing and identification of mutations with microarray (DR 50 to 75% for PKD1 and 75 % for ADPKD)
- If no family history, tuberous sclerosis should be excluded
- Serial ultrasounds to assess liquor volume
- Renal and paediatric input
- Refer parents and siblings for renal ultrasound

#### Degree of hydronephrosis is significant: AP diameter >6mm in 2nd trimester
- Postnatal risks greater if >6mm in 2nd and >10 in 3rd trimester
- Isolated mild pyleostasis doesn't inc risk of aneuploidy
- Serial US: monitor bladder distension and AFI
- Can assess fetal urinary component in specialized centers to determine which fetuses may benefit from intervention: healthy fetus-hypotonic urine, progressive renal damage -isotonic urine
- Fetal intervention (vesicaamniotic shunting and fetal cystoscopic ablation of PUV) improves lung function but not of renal benefit.
- Renal and paediatric input

#### Genetic analysis may be indicated
- Serial ultrasounds to assess liquor volume and kidneys
- Often transient

### Outcomes

- Recurrent urinary infections
  - Gross hematuria (40% adults)
  - Cystic hepatic and liver disease: relatively common in adults.
  - 50% will progress to ESRD needed dialysis and renal transplant
  - ADPKD: Hypertension in 1st year of life
  - Asymptomatic until later in life
  - Develop hypertension, renal failure, hemangomas and aneurysms

- Morbidity and mortality directly linked to cause
- Unilateral: survival 100%, may require surgery later in life
- Bilateral with oligohydramnios: worst outcome, develop pulmonary hypoplasia and compression deformities of skeletal system
- Oligohydramnios in the 2nd trimester usually fatal

#### Very small

- Small (2-3%) unless associated with genetic syndrome
- 50% if one parent is affected
- Poor postnatal abnormalities
- Excellent outcome
- Possible small risk of ADPKD in adulthood

#### Unknown

- Dependent on associated condition