Amniotic Fluid and Fetal Membranes

Chapter 58

Amniotic Fluid

- **Allows fetus to move freely while:**
  - **Maintaining intrauterine temperature**
  - **Protecting the developing fetus from injury**
- **Abnormalities may:**
  - **Interfere with normal fetal development**
  - **Cause structural abnormalities**
  - **Represent indirect sign of underlying anomaly**
    - **Neural tube defect**
    - **Gastrointestinal disorder**

Amniotic Fluid

- Produced by
  - Umbilical cord and membranes
  - Lungs
  - Skin
  - Kidneys
- Amniotic fluid production and consumption, and composition and volume
  - Depends on gestational age

- **Early gestation**
  - **Major source of fluid is the amniotic membrane**
    - **Water crosses the membrane freely**
    - **Production of fluid is accomplished by active transport of electrolytes by the amnion**

- **As the fetus and placenta mature**
  - **Fluid production and consumption change to include movement of fluid across**
    - **Chorion frondosum**
    - **Fetal skin**
    - **Fetal urine output**
    - **Fetal swallowing**
    - **Gastrointestinal absorption**

Chorion Frondosum

- **Portion of the chorion that develops into the fetal portion of the placenta**
- **Site where water is exchanged freely between fetal blood and amniotic fluid across the amnion**

- **Fetal production of urine and the ability to swallow begin between 8 to 11 weeks**
  - **Major pathways for amniotic fluid production and consumption after this time period**
- **Fetus swallows amniotic fluid**
  - **Absorbed by the digestive tract**
- **Fetus produces urine**
  - **Passed into the surrounding amniotic fluid**

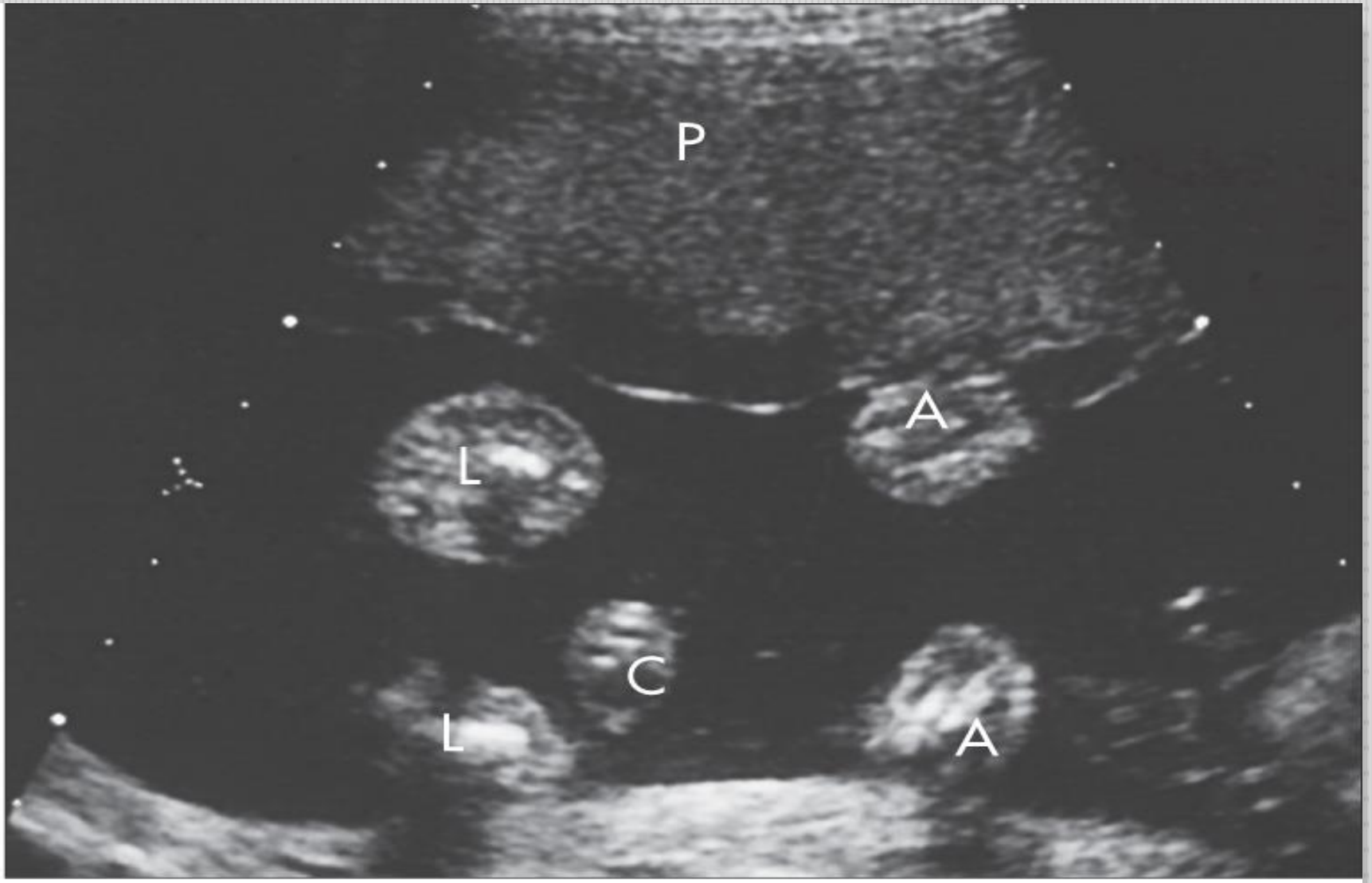
- **Fetal urination accounts for nearly the total volume of amniotic fluid by the second half of pregnancy**
  - **Quantity directly related to kidney function**
- **Fetus with malformed kidneys or renal agenesis produces little or no amniotic fluid**

- **Amount of fluid is also regulated by:**
  - **Removal of the fluid by swallowing**
  - **Fluid exchange within the lungs**
  - **The membranes and cord**
- **Normal lung development is critically dependent on the exchange of amniotic fluid within the lungs**
- **Inadequate lung development may occur when severe oligohydramnios is present**
  - **Places fetus at high risk for developing small or hypoplastic lungs**

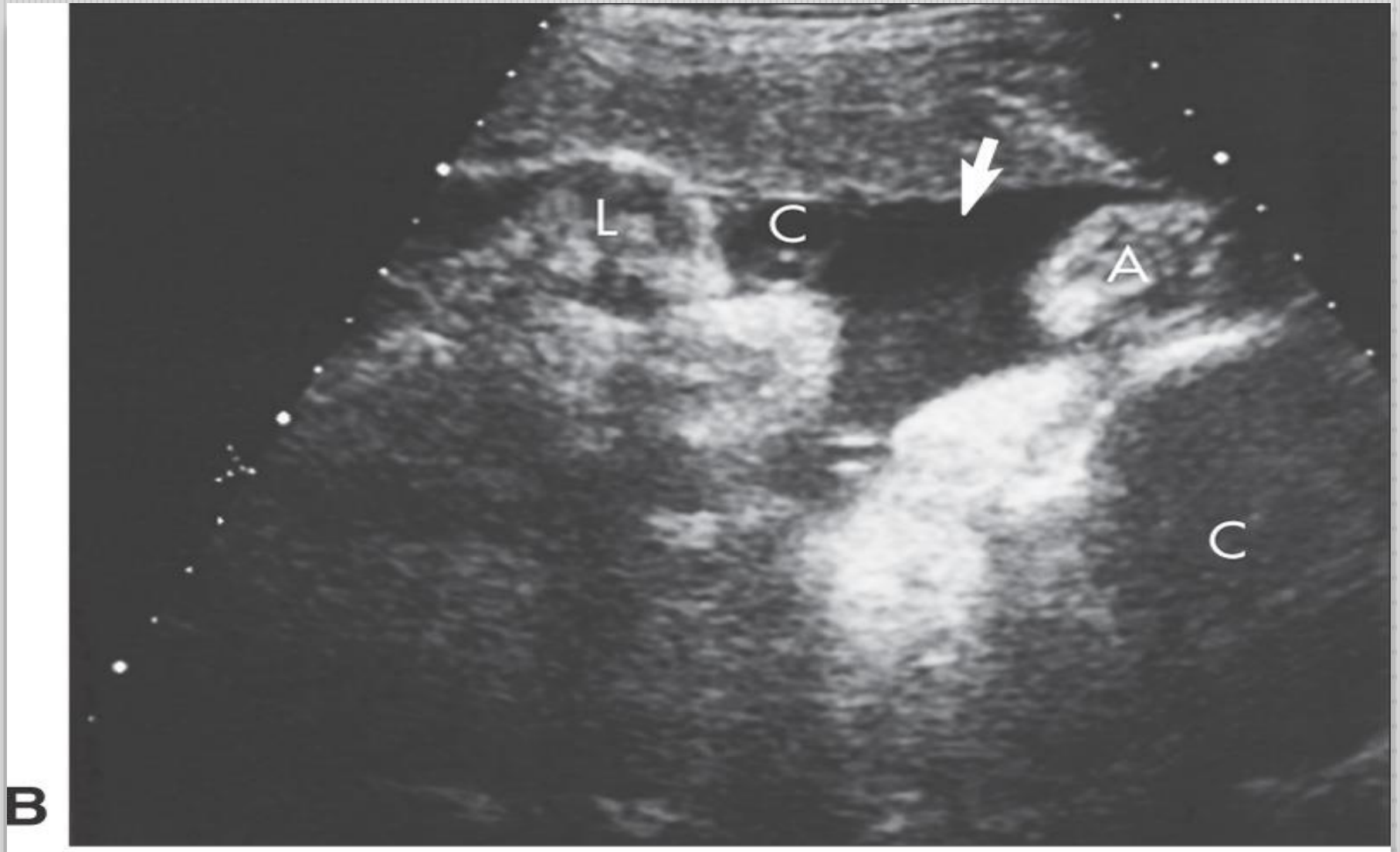
- **Amniotic fluid has six functions:**
  1. **Acts as a cushion to protect the fetus**
  2. **Allows embryonic and fetal movements**
  3. **Prevents adherence of amnion to the embryo**
  4. **Allows symmetrical growth**
  5. **Maintains a constant temperature**
  6. **Acts as a reservoir to fetal metabolites before their excretion by the maternal system**

Normal Amniotic Fluid Volume

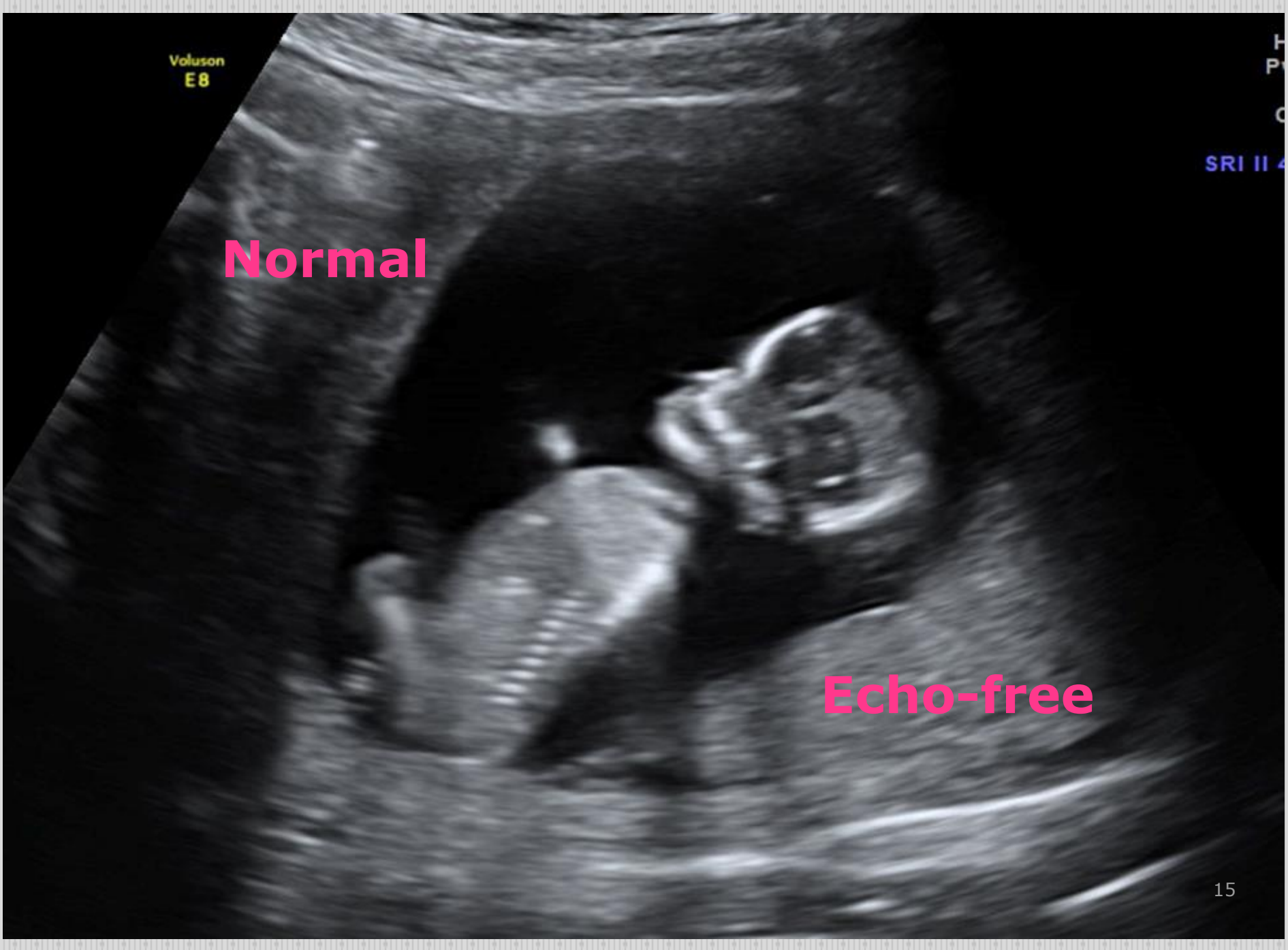
- **Volume increases progressively until about 33 weeks gestation**
- **During second and early third trimester**
  - **Fluid appears to surround the fetus and should be readily apparent**
- **From 20 to 30 weeks**
  - **Fluid may appear somewhat generous**
  - **This typically represents a normal fluid variant**



Typical Abundance - 20 wks



Typical Amount – 35 wks


Voluson
E8
SRI II
Normal
Echo-free

- **By the end of pregnancy, amniotic fluid is scant**
  - **Isolated fluid pockets may be visible**
- **Fluid generally appears echo free**
  - **Occasionally fluid particles can be seen**
    - **Vernix caseosa (fatty material found on fetal skin and in amniotic fluid late in pregnancy) may be seen within the amniotic fluid**


Vernix

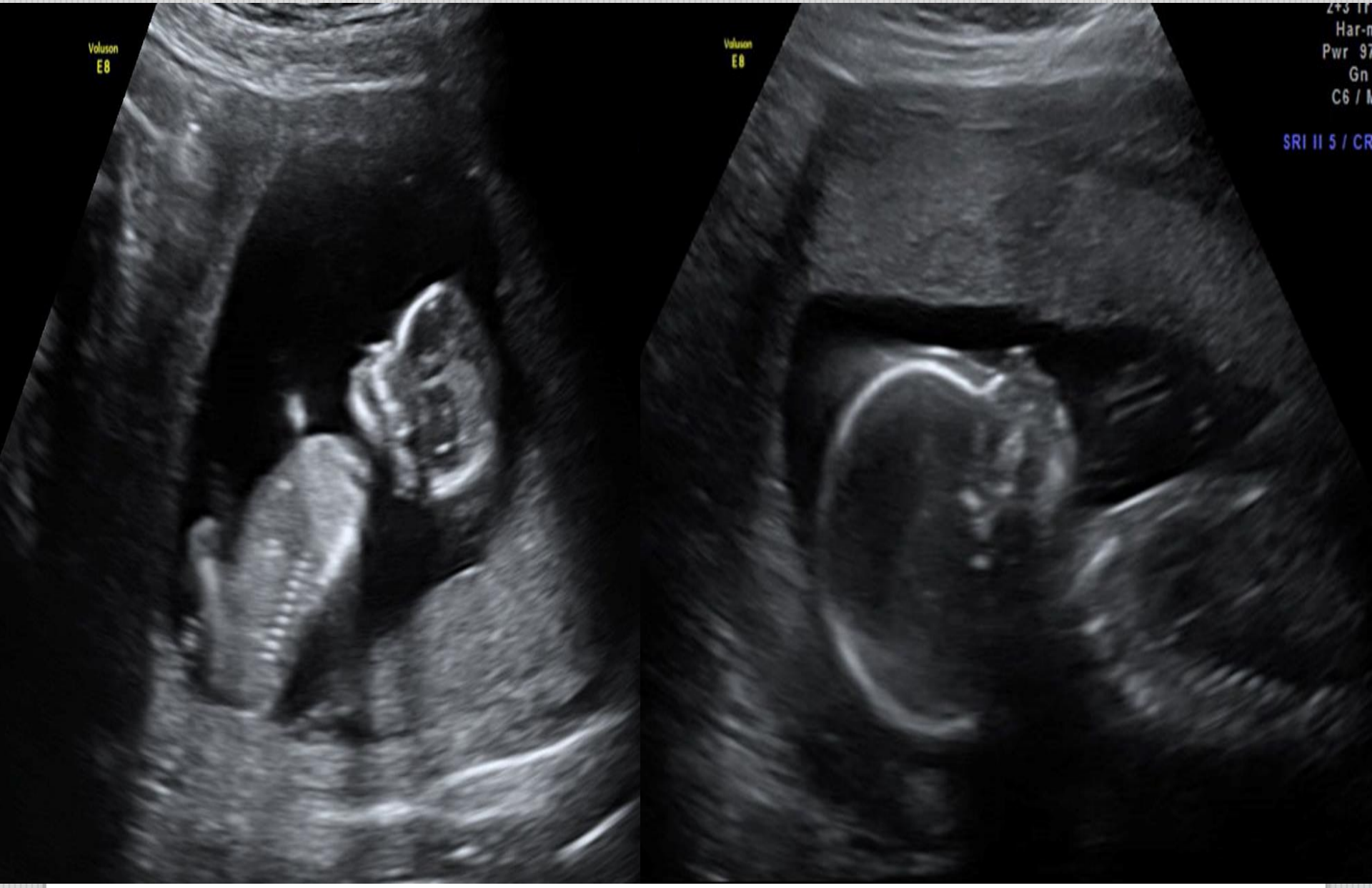
- **Subjective observation of fluid volumes throughout pregnancy helps the sonographer determine the norm and extremes of amniotic fluid**
  - **Amniotic fluid index aids in estimating the amount fluid present**
  - **Amount of fluid volume correlates with fetal and placental weight**
    - **Small-for-dates has decreased amniotic fluid**
    - **Large-for-dates has increased volume of fluid**

Assessment of Abnormal Amniotic Fluid Volume

- **Different ways to assess the amount of amniotic fluid**
- **Assessment is important in the 2nd & 3rd trimesters to help determine the well-being of the fetus**
- **Several methods of measurement**
  - **Subjective assessment**
  - **Four quadrant assessment**
  - **Measurement of the single deepest pocket of fluid**

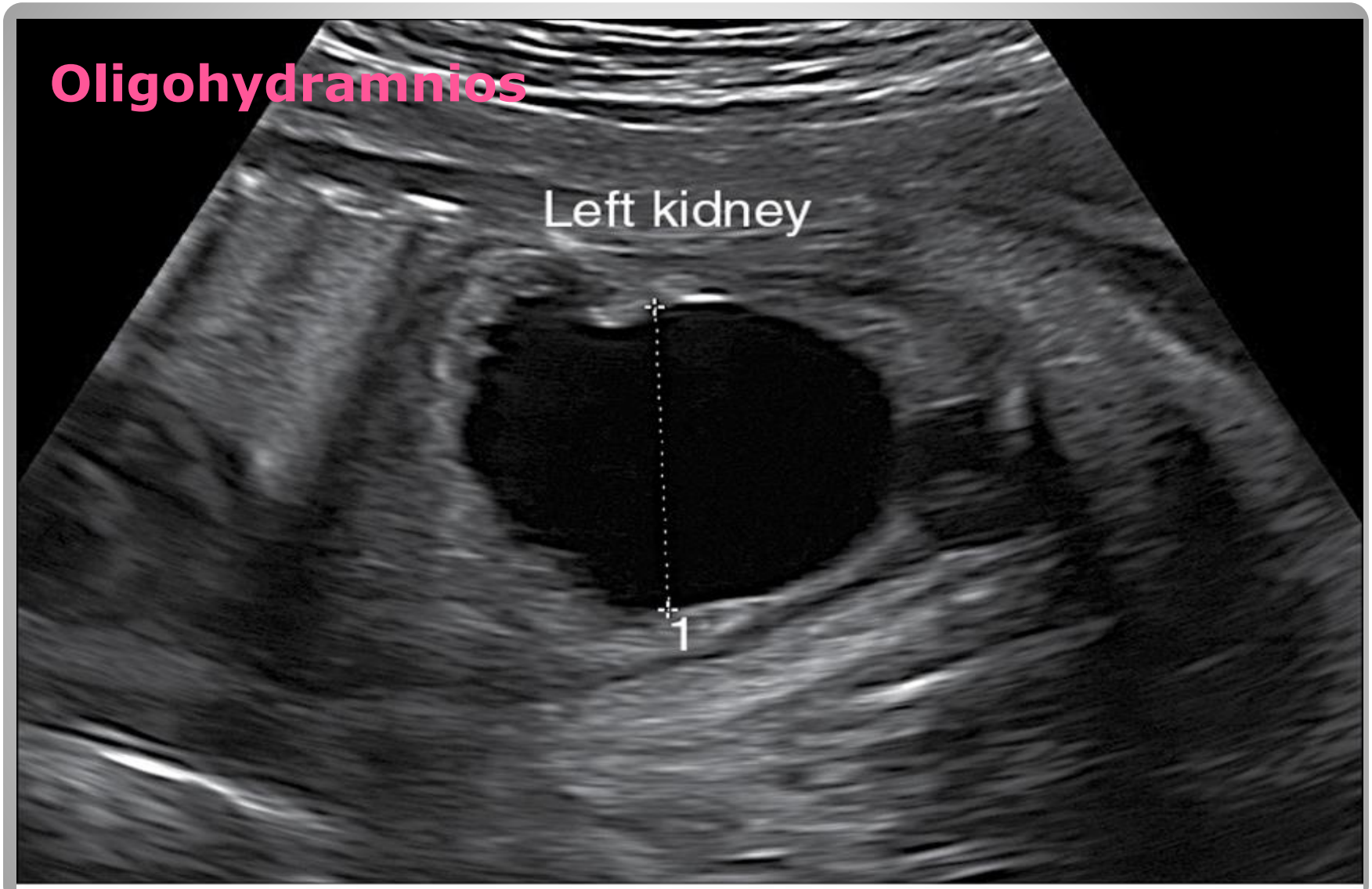
Subjective Assessment

- **"eyeball" assessment of:**
  - **Fluid present**
  - **Fetal lie**
  - **Placenta position**
- **More successful with experienced sonographers**



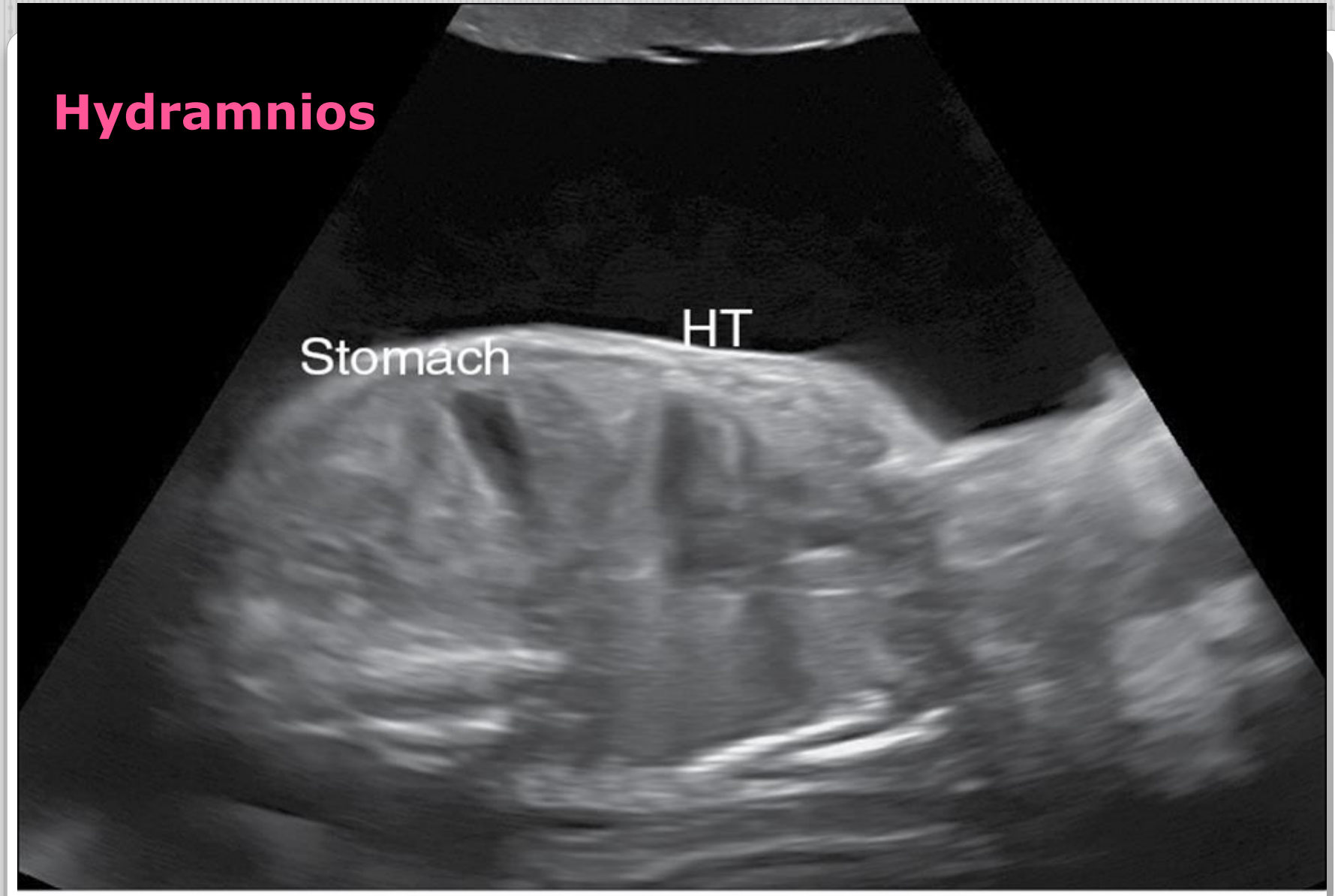
Eyeball Assessment

Oligohydramnios



Eyeball Assessment

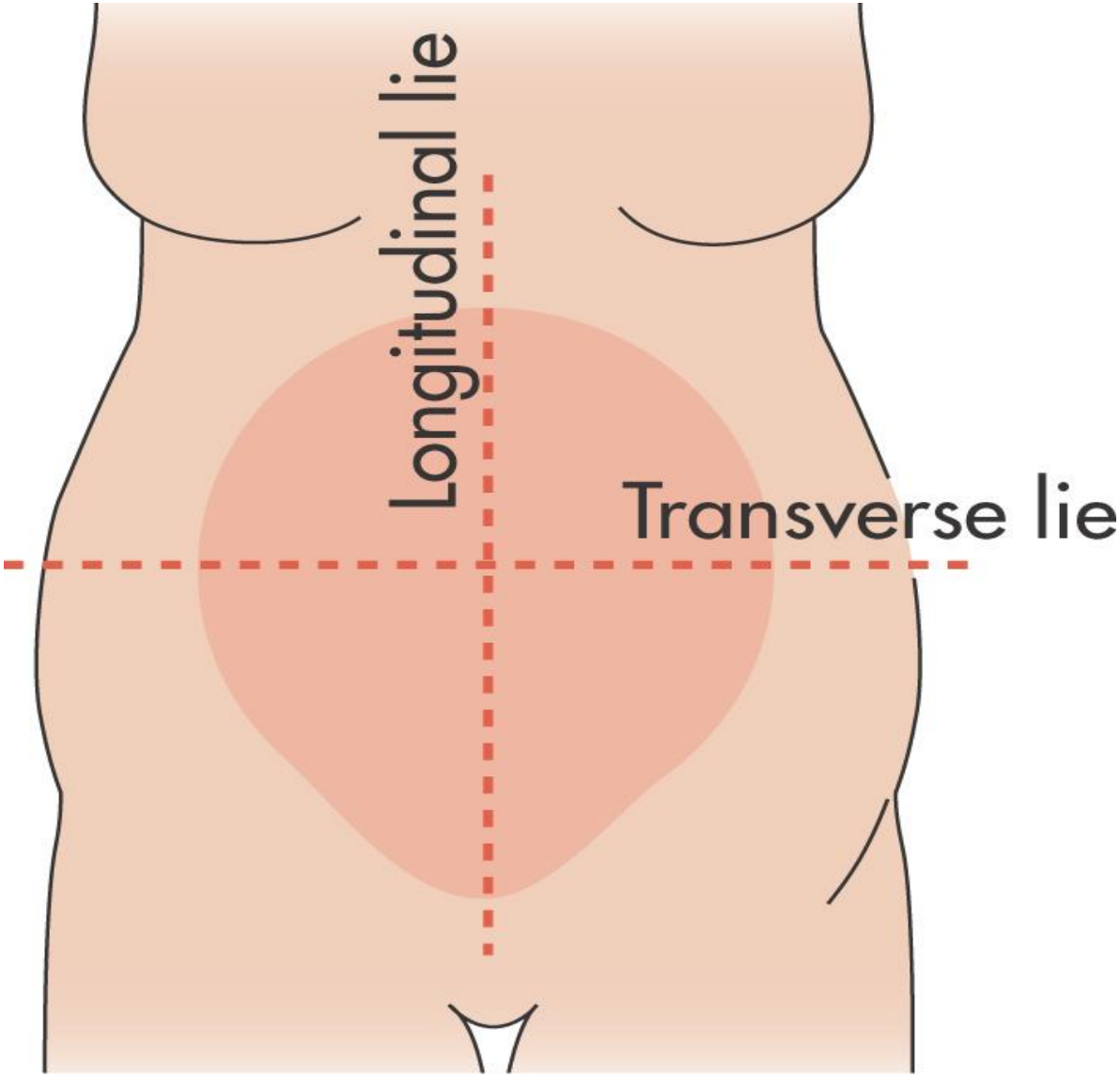
Hydramnios



Eyeball Assessment

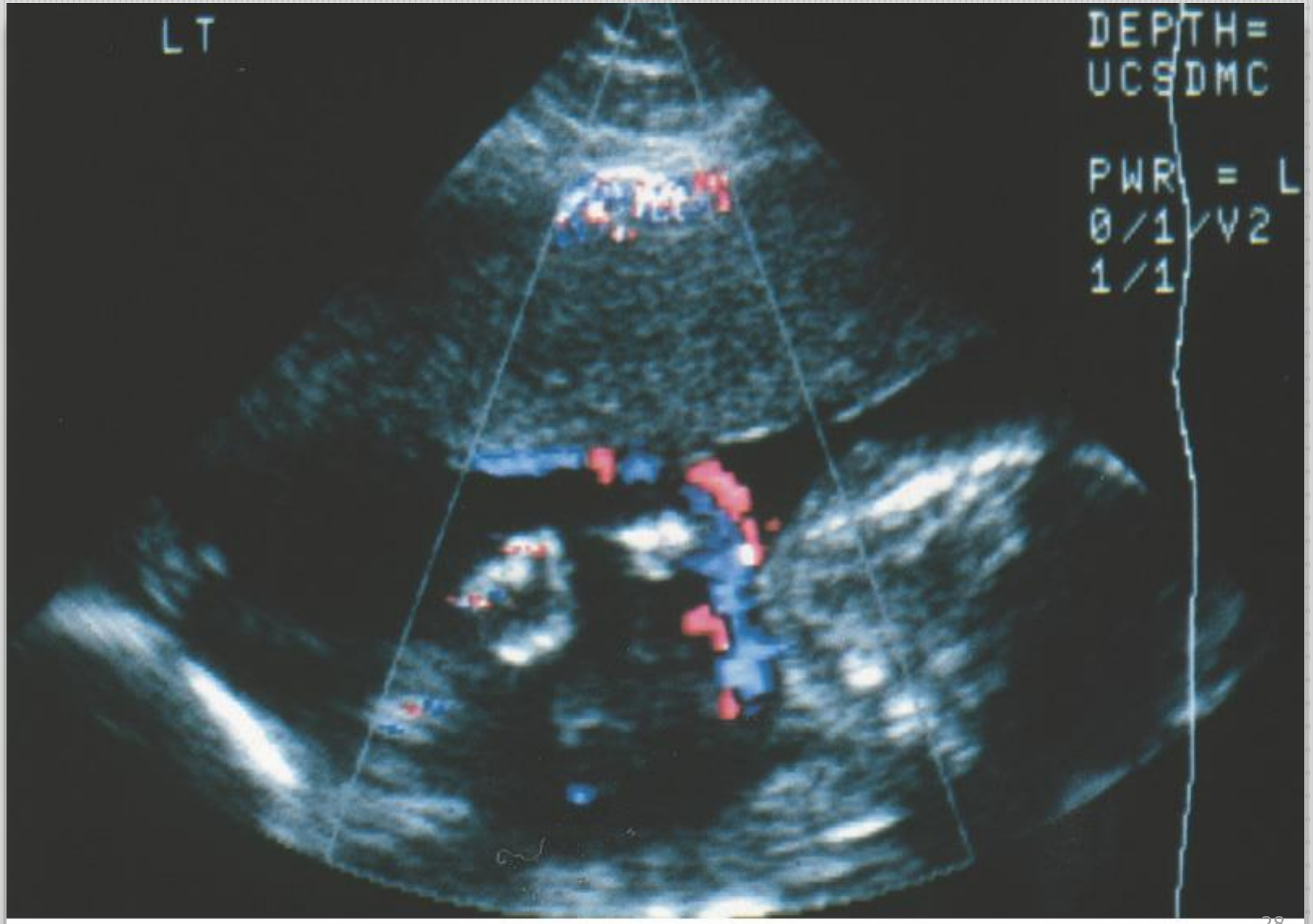
Four Quadrant Assessment

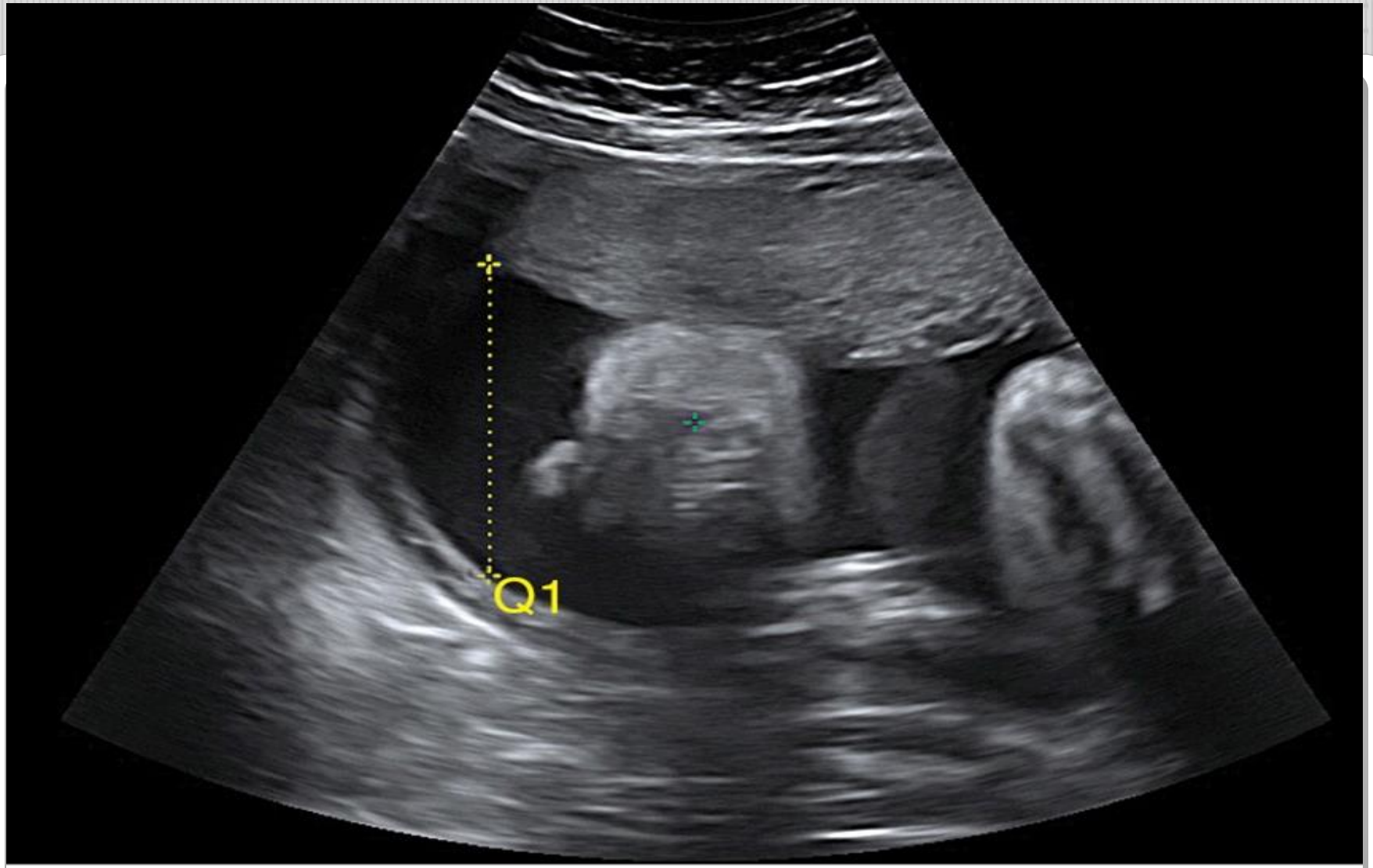
- Evaluating and quantifying amniotic fluid volume
- Divide cavity into four quadrants
  - Measure largest vertical pocket
    - Excluding limbs and cord
- Sum of four quadrants
  - Amniotic fluid index (AFI)
    - Normal 10 to 20 cm
      - Oligo < 5 cm
      - Poly > 24 cm



Four Quadrant Assessment

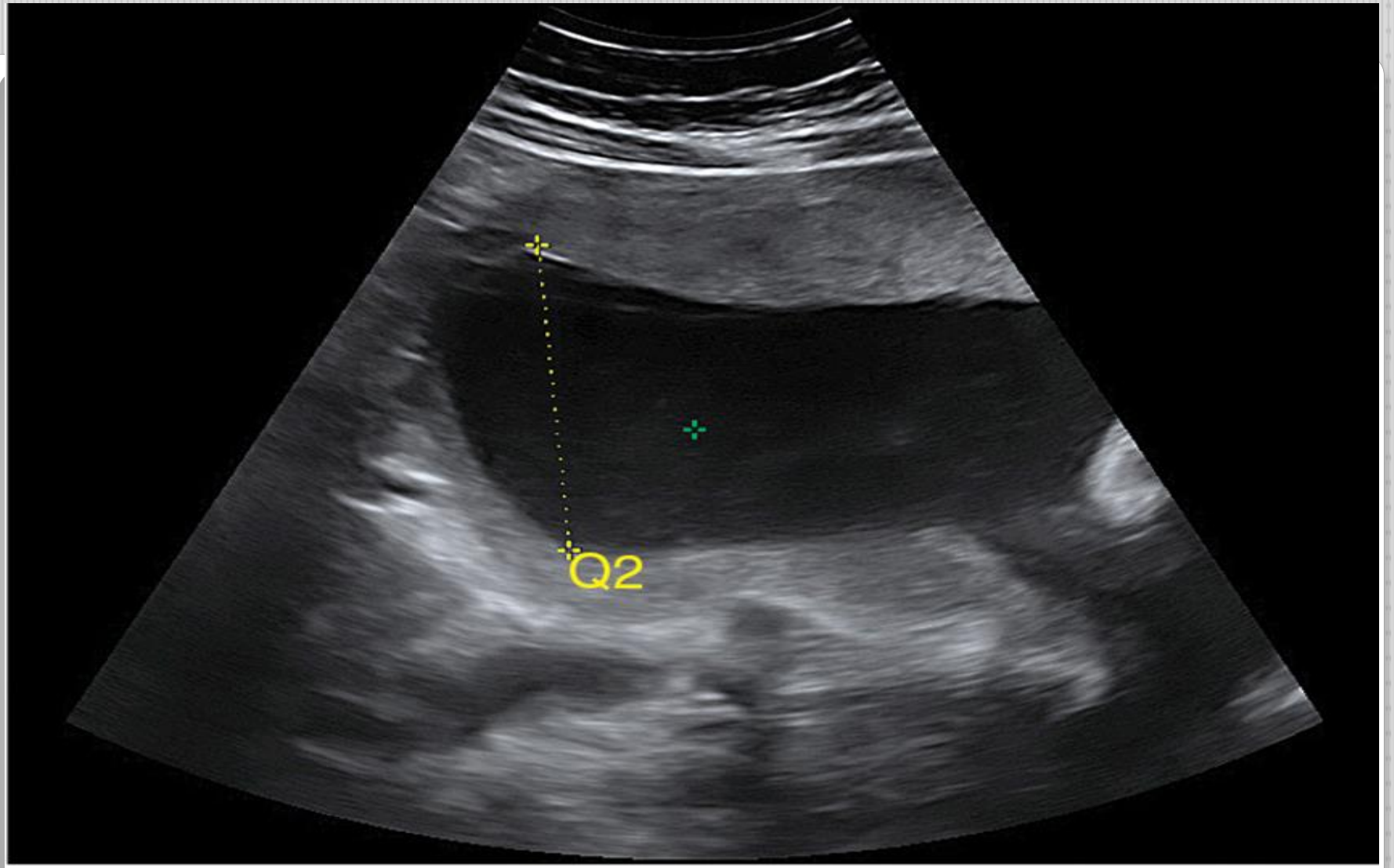
- Hold transducer sagittally and perpendicular to the table (not the curved skin surface)
- Do not include the thickness of the maternal uterine wall
  - Uterine wall may be determined with a slight increase in gain
- Color helps separate the umbilical cord loops from fluid
- Move transducer until the cord loops and/or fetal limbs are not within the pocket





A

Quadrant 1



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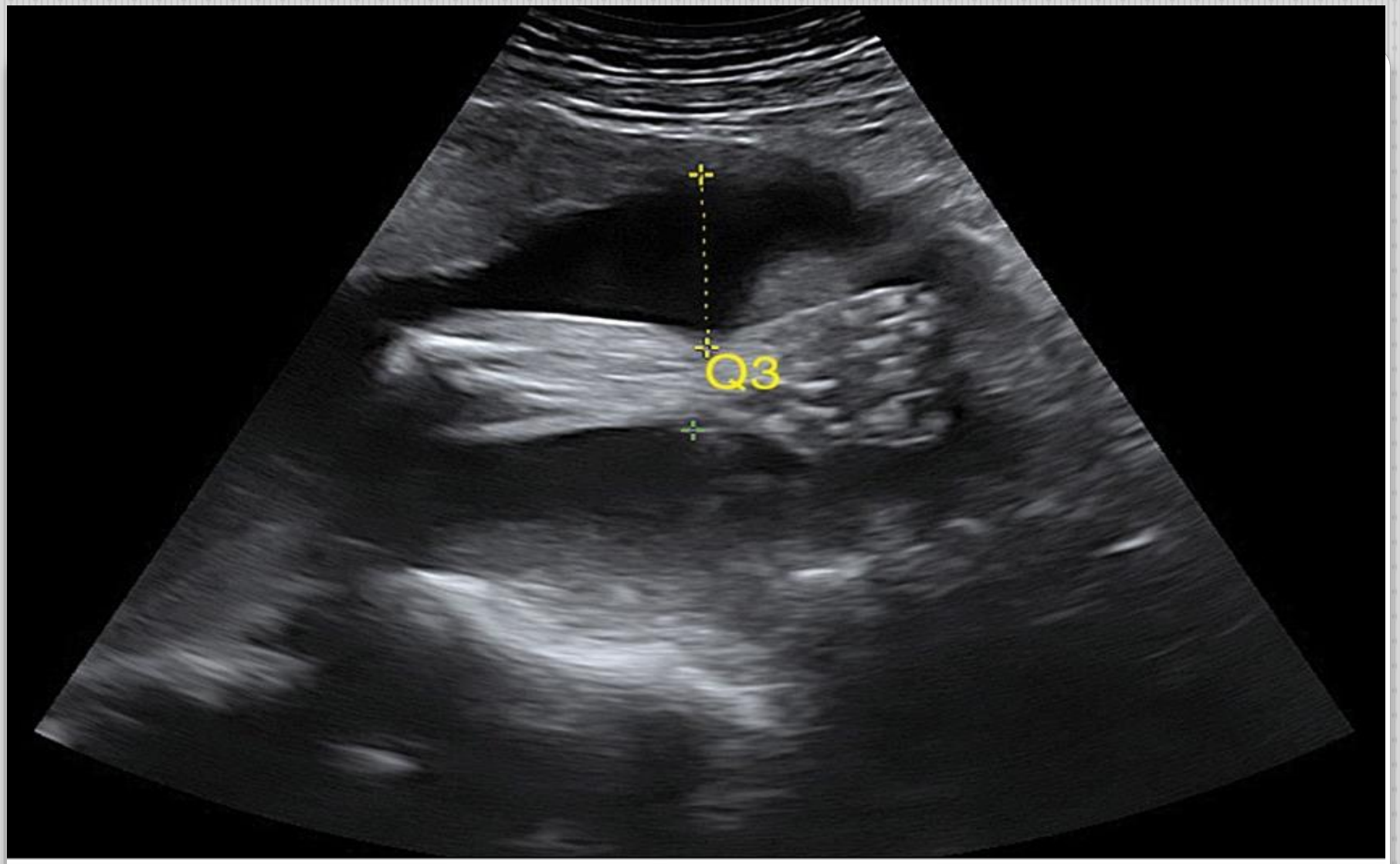
Quadrant 2



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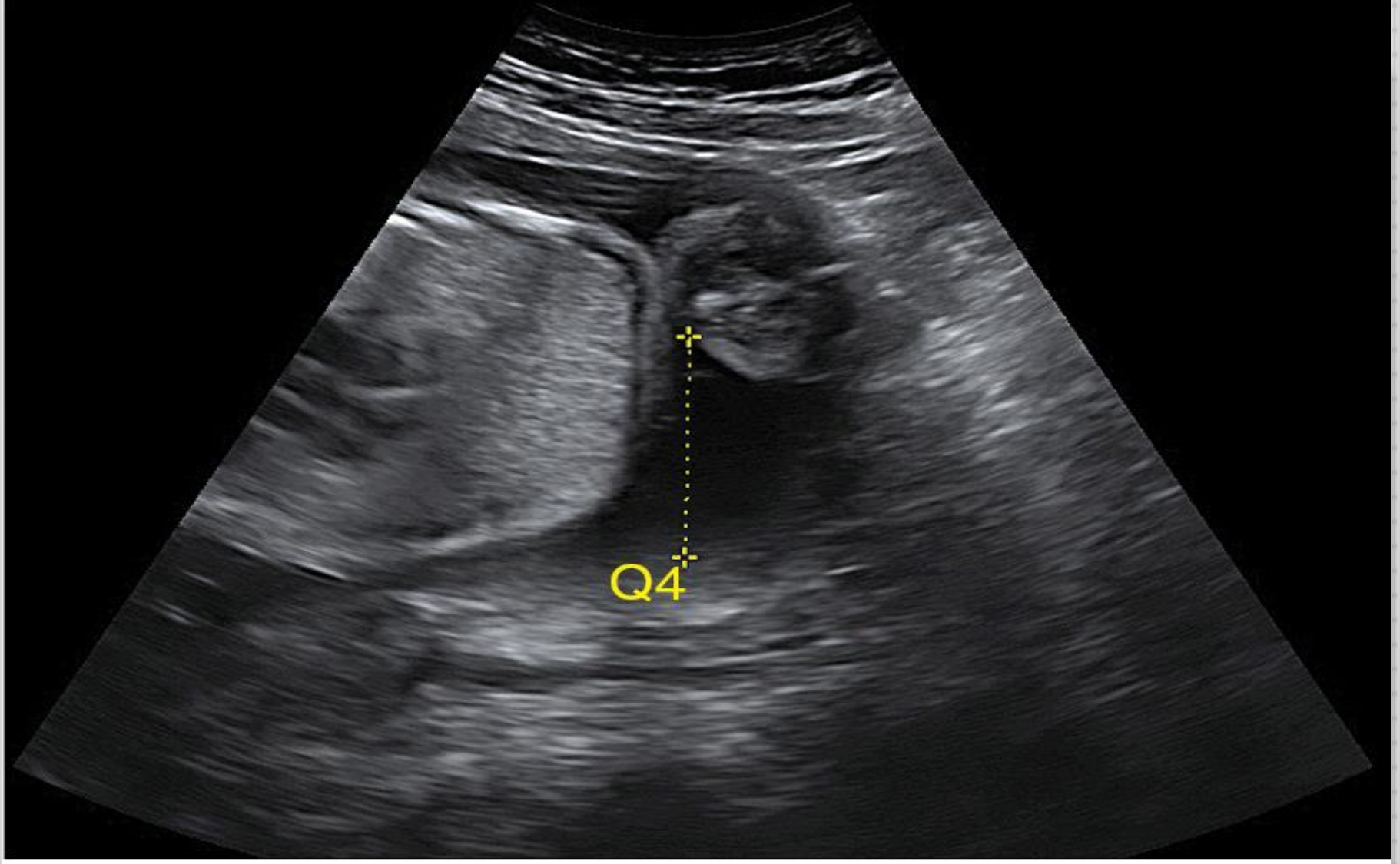
Quadrant 3

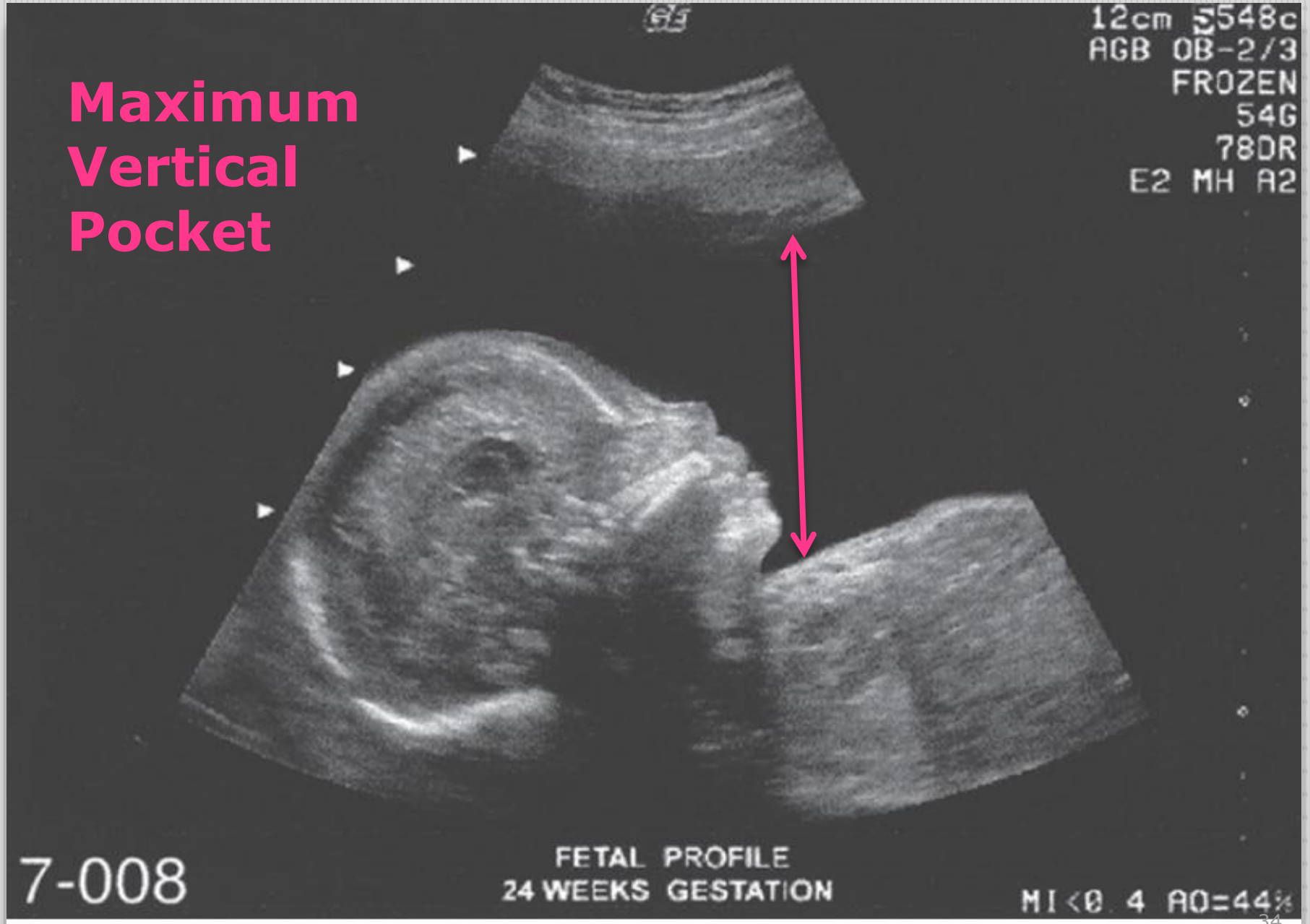


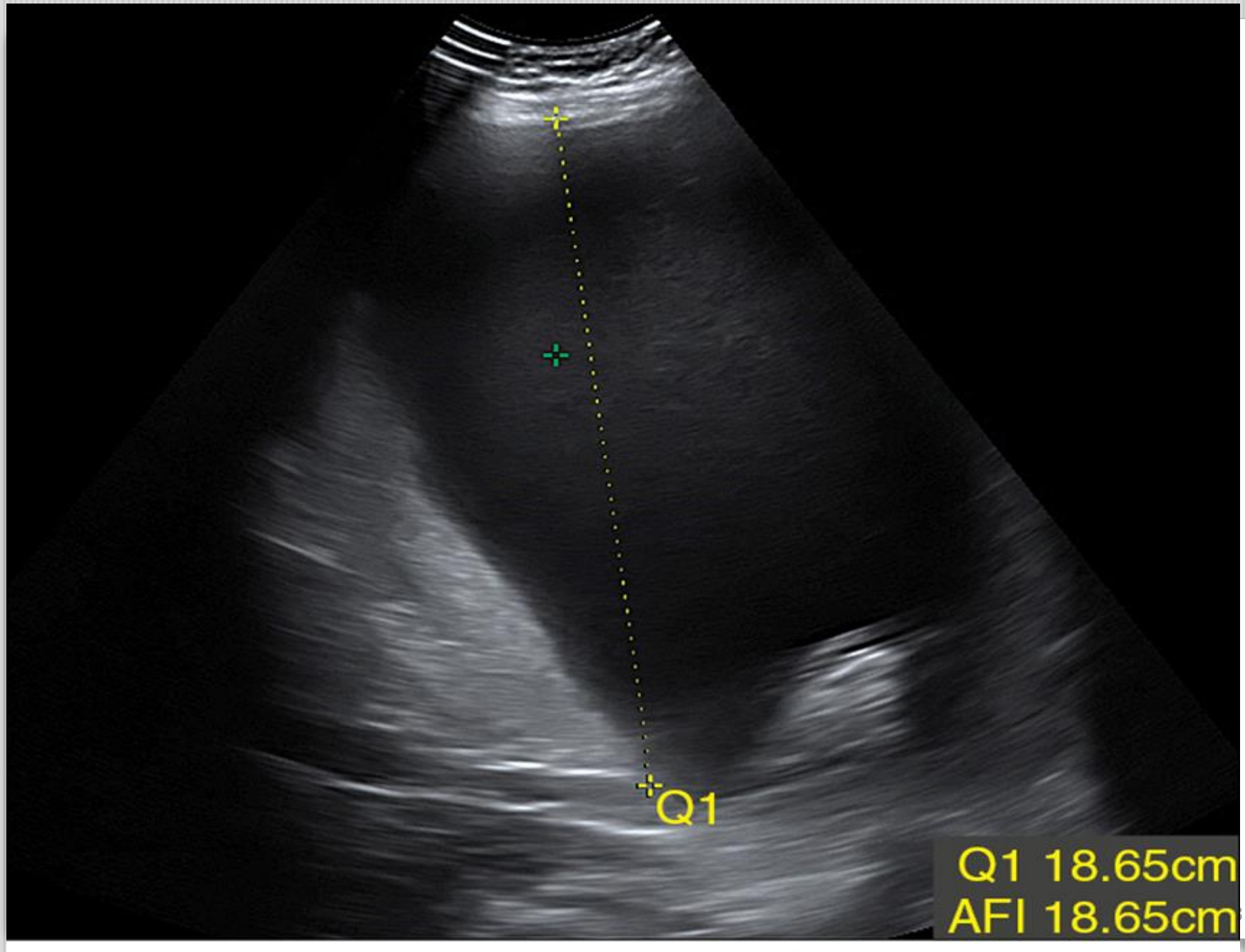
D

Quadrant 4

Single Pocket Assessment

- Maximum vertical pocket
  - Identify largest pocket
    - Measure depth at right angles to uterine contour
    - 3 categories
      - < 2 cm – Oligo
      - 2-8 cm – Normal
      - > 8 – Poly

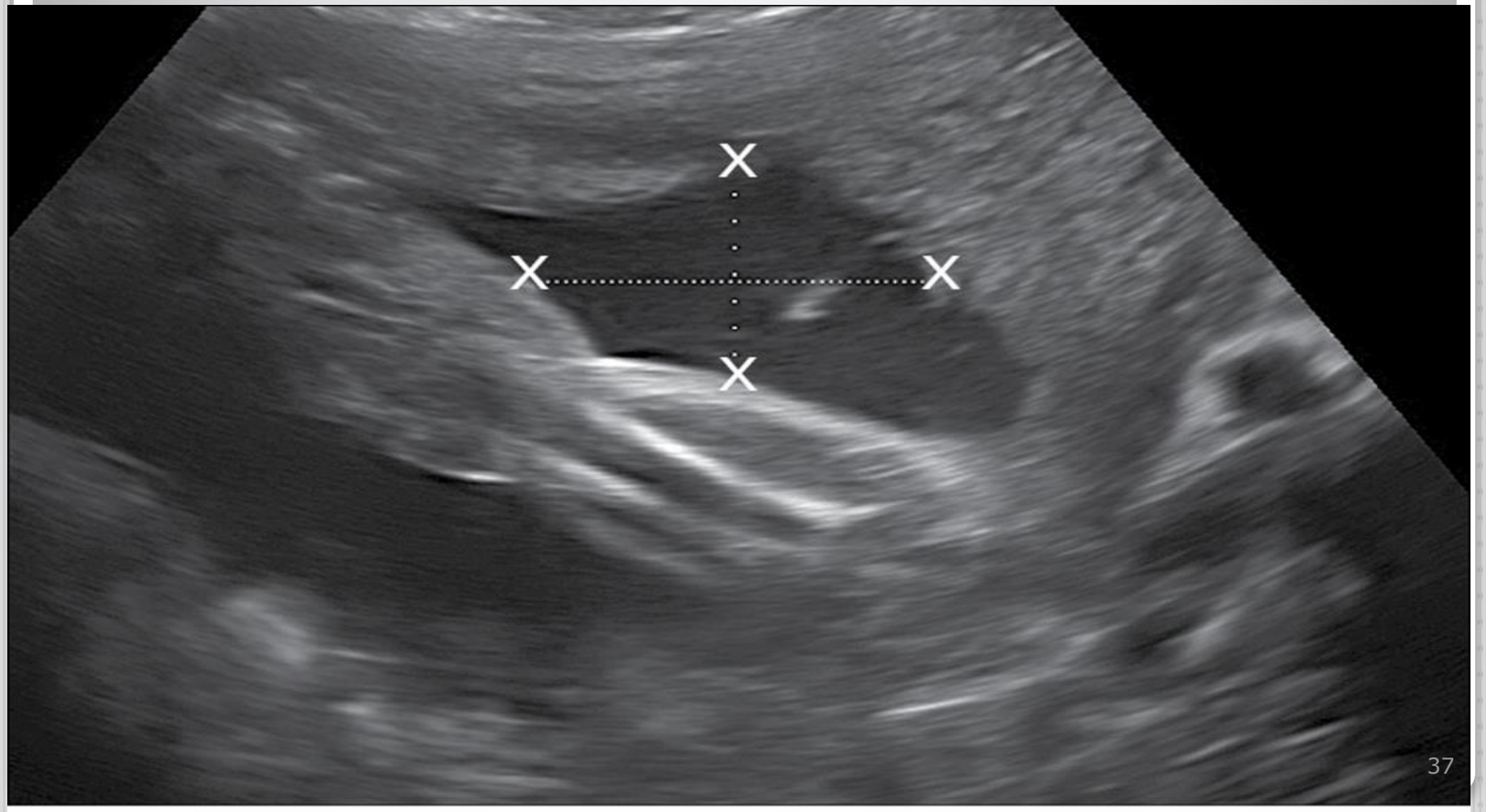




Two-Diameter Pocket Assessment

- Two dimensional determination
  - Largest pocket of fluid
    - Take both horizontal and vertical dimensions
  - Multiply both dimensions to obtain a single volume
  - 15-50 cm two-diameter pocket is considered normal

Two-Diameter Pocket Assessment



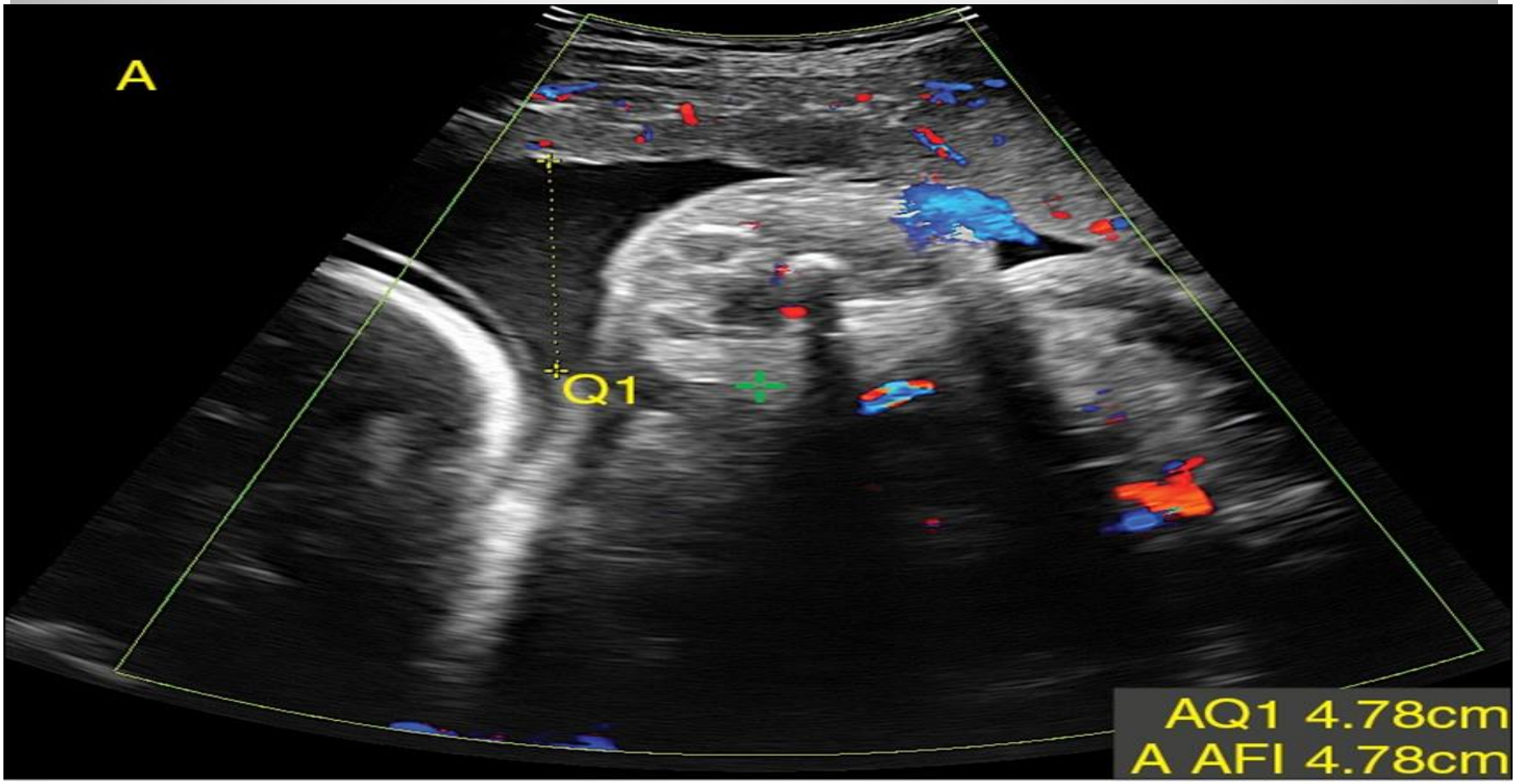
The Preferred Method

- AFI
  - Only technique that is both valid and reproducible
  - Helpful in a busy lab with multiple sonographers
    - May have varying subjective assessments of fluid
- Amniotic fluid volume should be one component of the total fetal assessment

Amniotic Fluid in Twin Pregnancies

- Important to assess each sac independently
- Twin pregnancies have a slightly lower median AFI value than singleton pregnancies
- Two-dimensional pocket measurement appears to be a better predictor of oligohydramnios than the AFI or the largest vertical pocket

Amniotic Fluid in Twin Pregnancies



A

Abnormal Amniotic Fluid Volume

- Abnormal volumes may suggest fetus has a congenital anomaly
  - Poly
  - Oligo

Polyhydramnios

- "Hydramnios"
- Defined as AF volume of >2000ml
- Increased perinatal mortality and morbidity and maternal complications
- Uterus larger than dates
- Sonography used to r/o multiple gestation, molar pregnancy, or incorrect dates

Polyhydramnios

- Produces uterine stretching and enlargement may lead to
  - Preterm labor
  - Variety of other maternal symptoms
    - Painful
    - Compress other organs or vascular structures
    - Cause hydronephrosis of the kidneys
    - SOB from compression of the organs on the diaphragm

Polyhydramnios

- **Often associated with central nervous system (CNS)disorders**
  - **Cause depressed swallowing**
- **Gastrointestinal abnormalities**
  - **Often a blockage (atresia) that results in ineffective swallowing**
    - **Esophagus**
    - **Stomach**
    - **Duodenum**
    - **Small bowel**

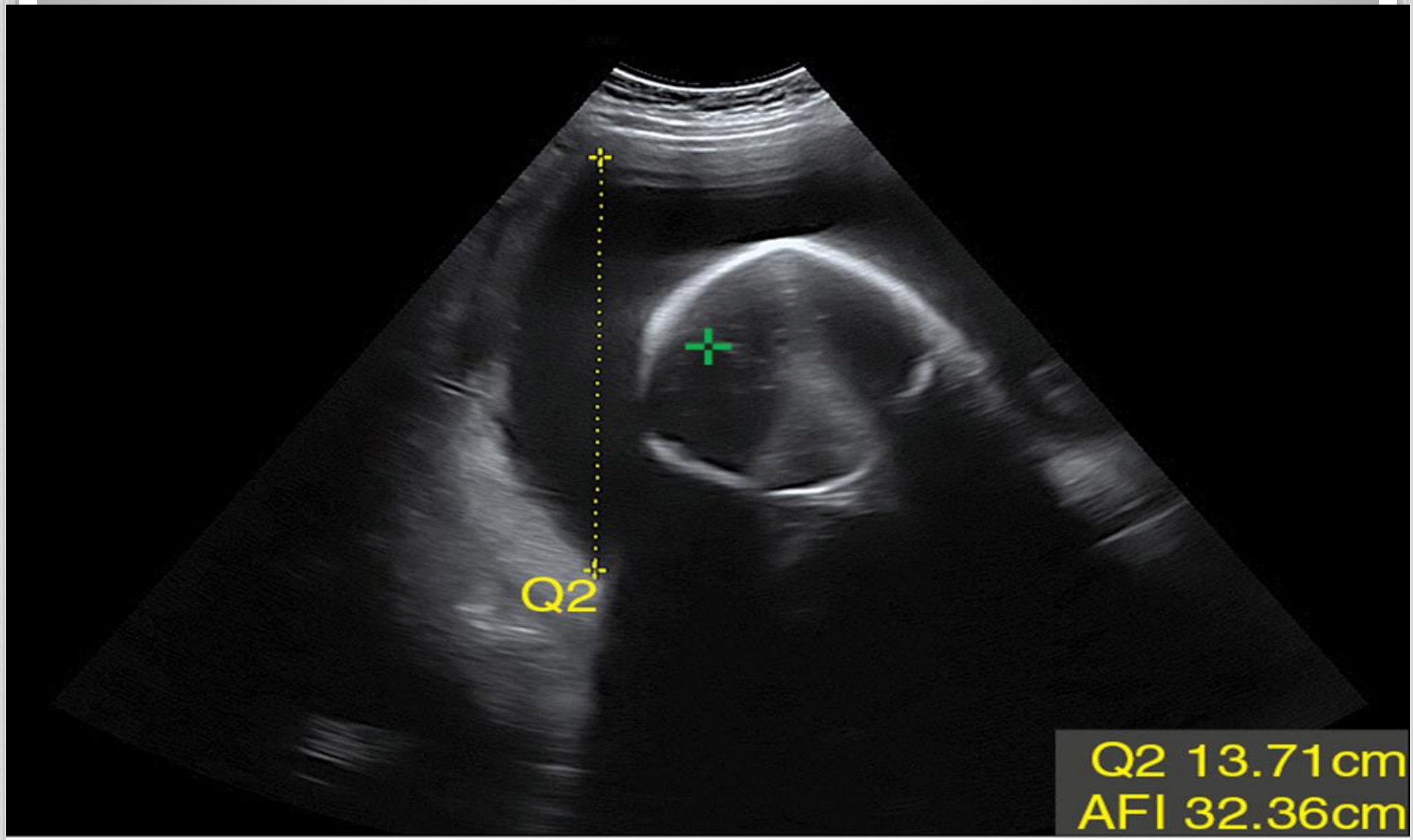
Polyhydramnios

- Other conditions associated include:
  - Fetal hydrops
  - Skeletal anomalies
  - Some renal disorders
    - Usually unilateral
  - Maternal diabetes mellitus
  - Fetal macrosomia
  - Rh isoimmunization

Polyhydramnios

- **Sonographically:**
  - **Freely floating fetus within swollen amniotic cavity**
  - **Accentuated fetal anatomy (increased AF improves image resolution)**
  - **AFI = 20 cm or greater**

Polyhydramnios



Oligohydramnios

- Overall reduction in amount of AF resulting in fetal crowding and decreased fetal movement
- Criteria based on
  - Subjective experience
  - Estimations of the AFI
- Defined as
  - Single pocket < 2cm
  - AFI < 5 cm
- Gray zone
  - Decreased fluid ranges from 5 to 10 cm with four-quadrant approach

Oligohydramnios

- Be careful when evaluating the fetal growth parameters
  - Fetal head and abdomen can be compressed
- Because the fetus lacks the surrounding fluid protecting it
  - Circumferences can actually be changed by transducer pressure on the maternal abdomen
- Transducer pressure may alter the estimated fetal weight

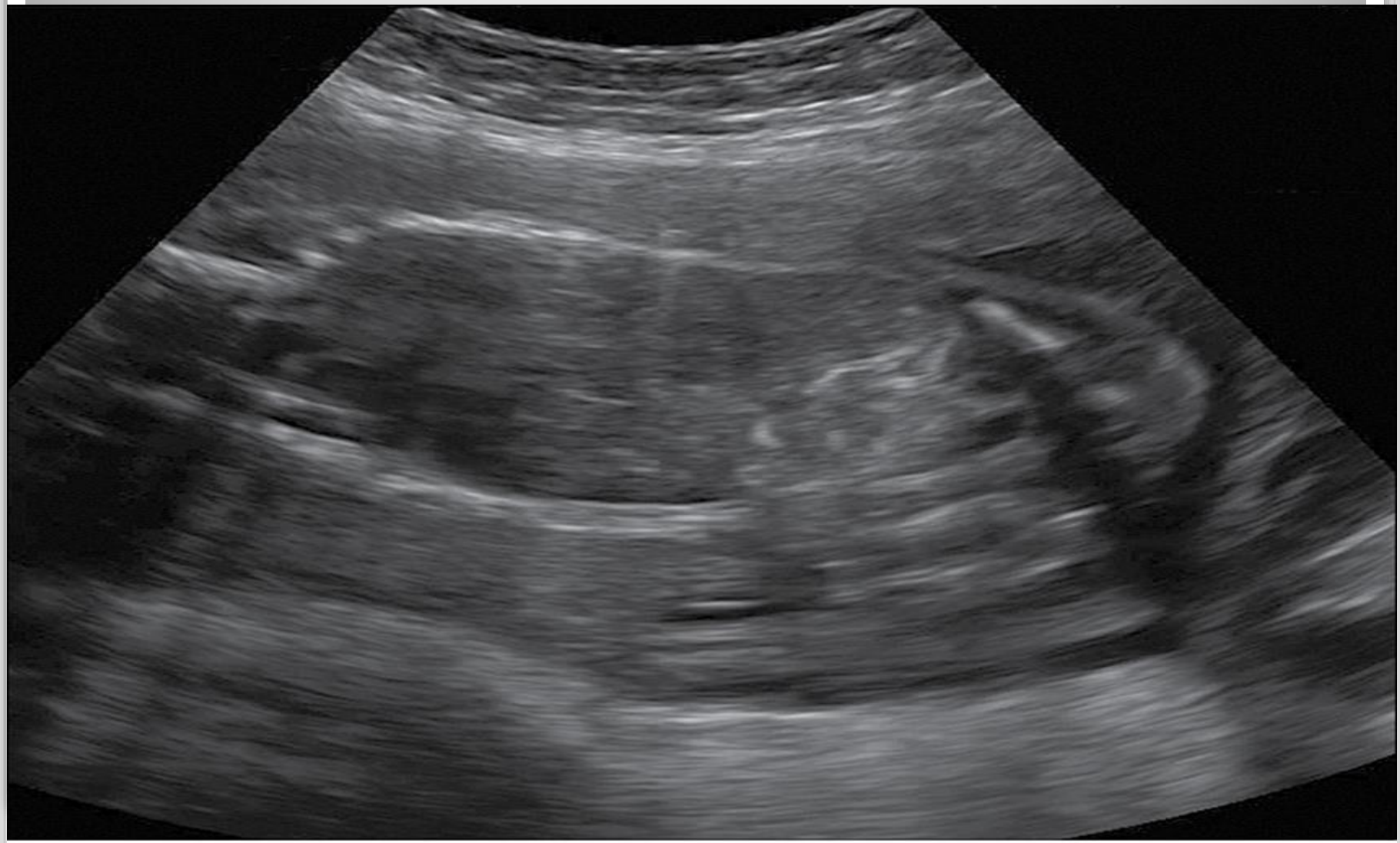
Oligohydramnios

- **Prolonged severe oligohydramnios may be the cause of fetal anomalies**
  - **Secondary to pressure on the fetus by the uterine wall**
- **Anomalies**
  - **Pulmonary hypoplasia**
  - **Abnormal facial features**
  - **Abnormal limb development**

Oligohydramnios

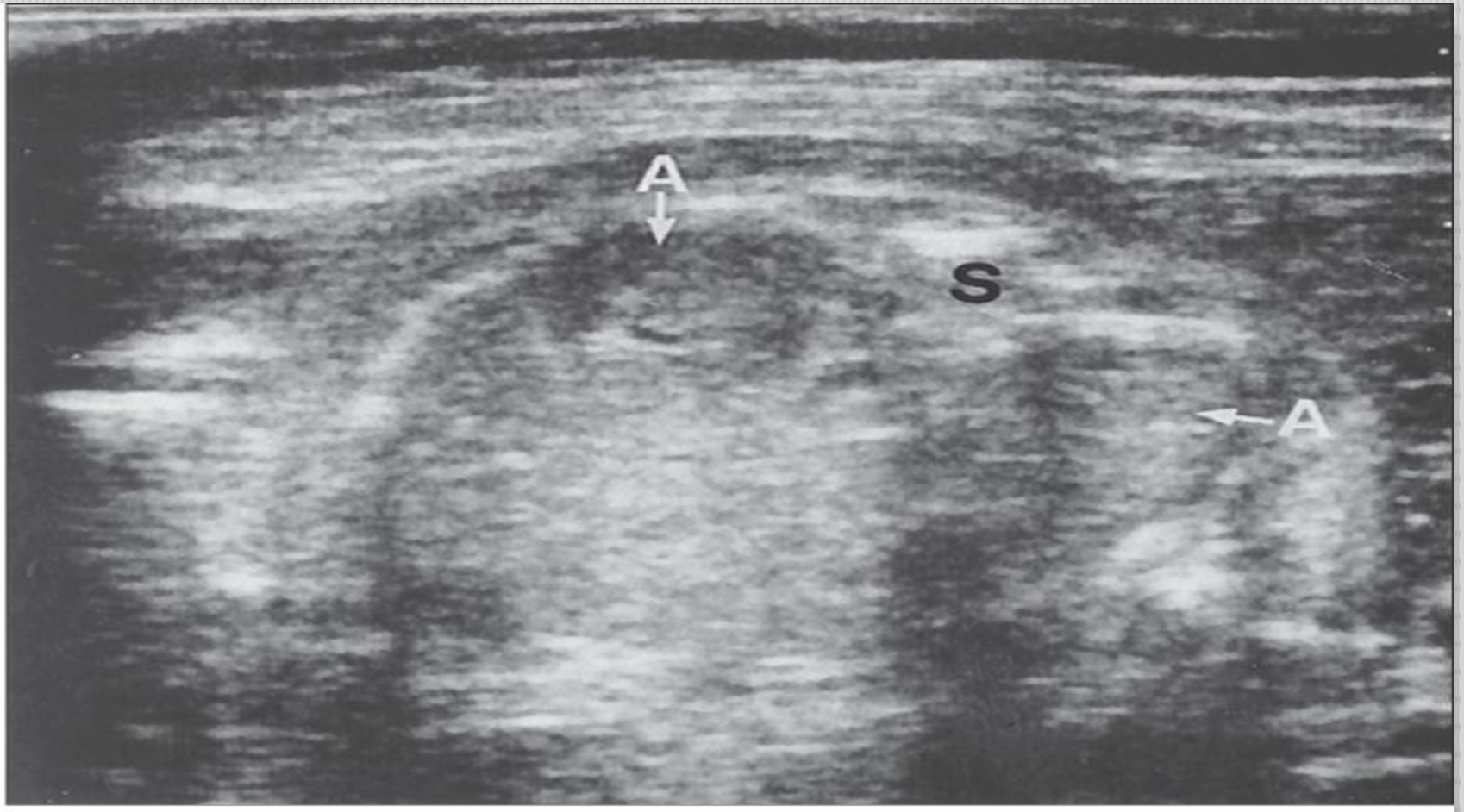
- Causes
  - Congenital anomalies (renal)
  - Intrauterine growth restriction (placental insufficiency)
  - Post-term pregnancies
  - Ruptured membranes
  - Iatrogenesis
    - Medications
    - Fluid loss
    - Prior procedures (CVS/Amnio)

Oligohydramnios



Fetal Anomalies Associated with Oligohydramnios

- **If intrauterine membranes are not ruptured**
  - **Before 28 weeks**
    - **Evaluate fetal renal system to rule out:**
      - **Renal agenesis**
      - **Infantile polycystic disease**
      - **Posterior urethral valve syndrome** 
        - **Prognosis is not good**



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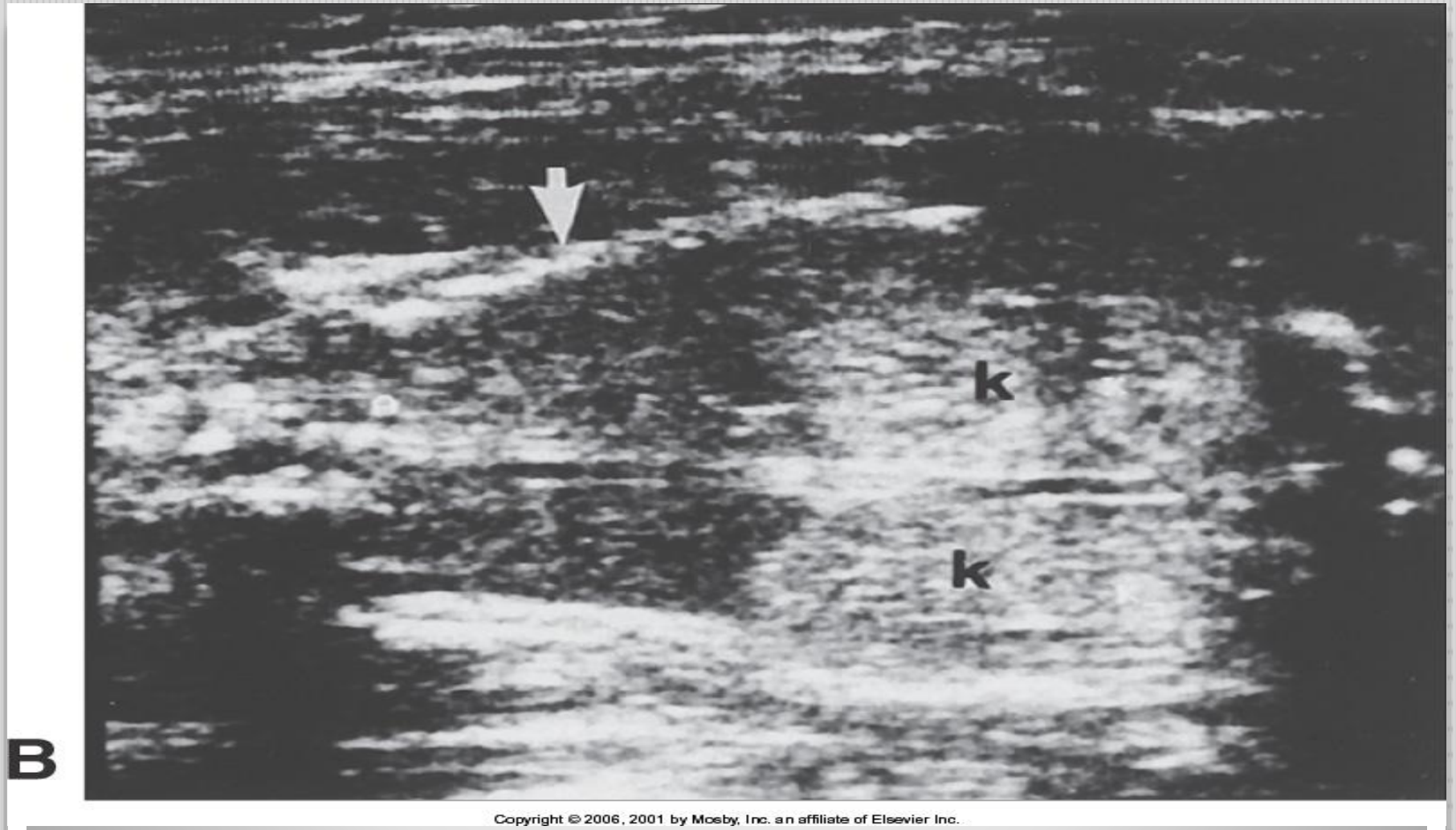
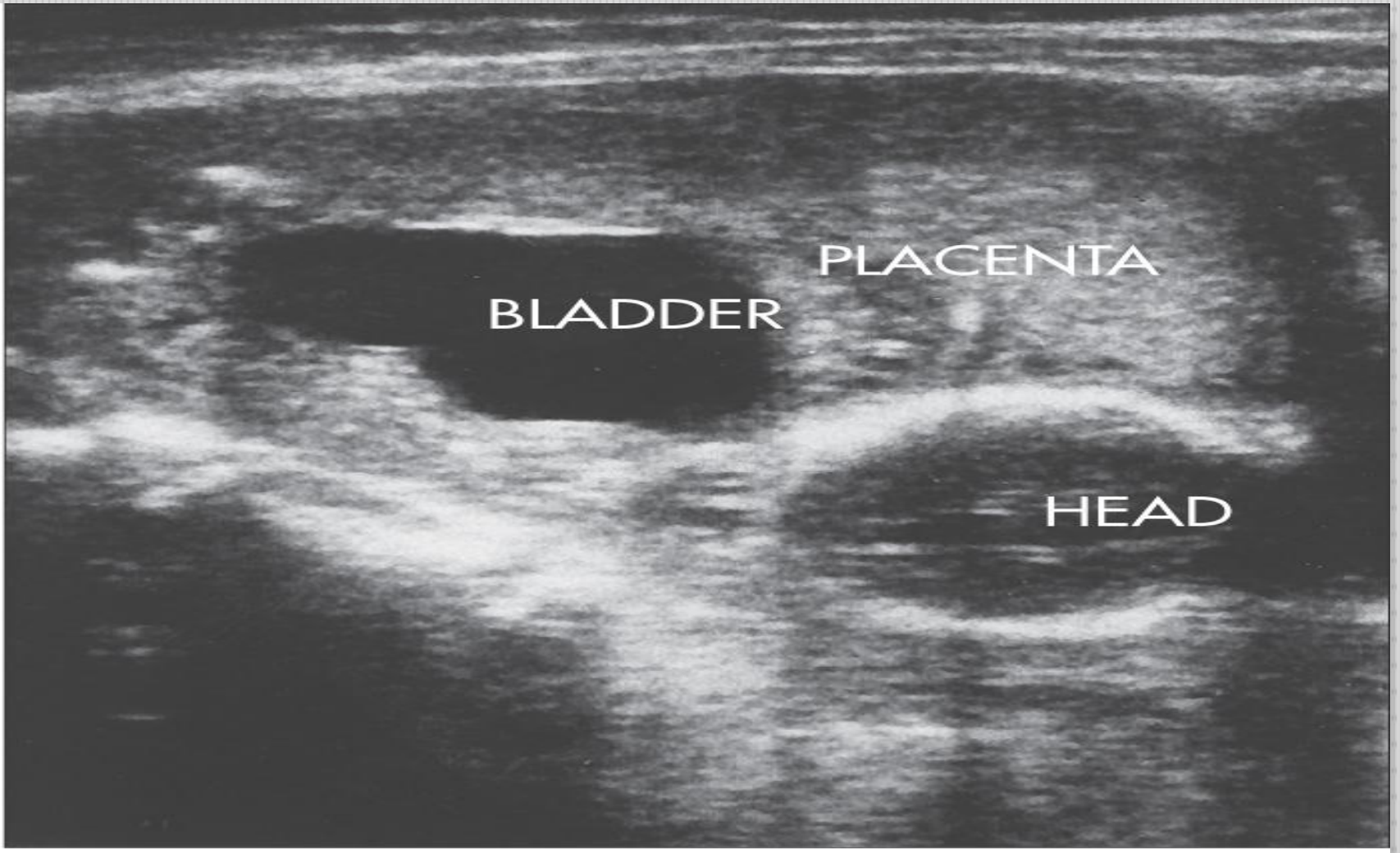
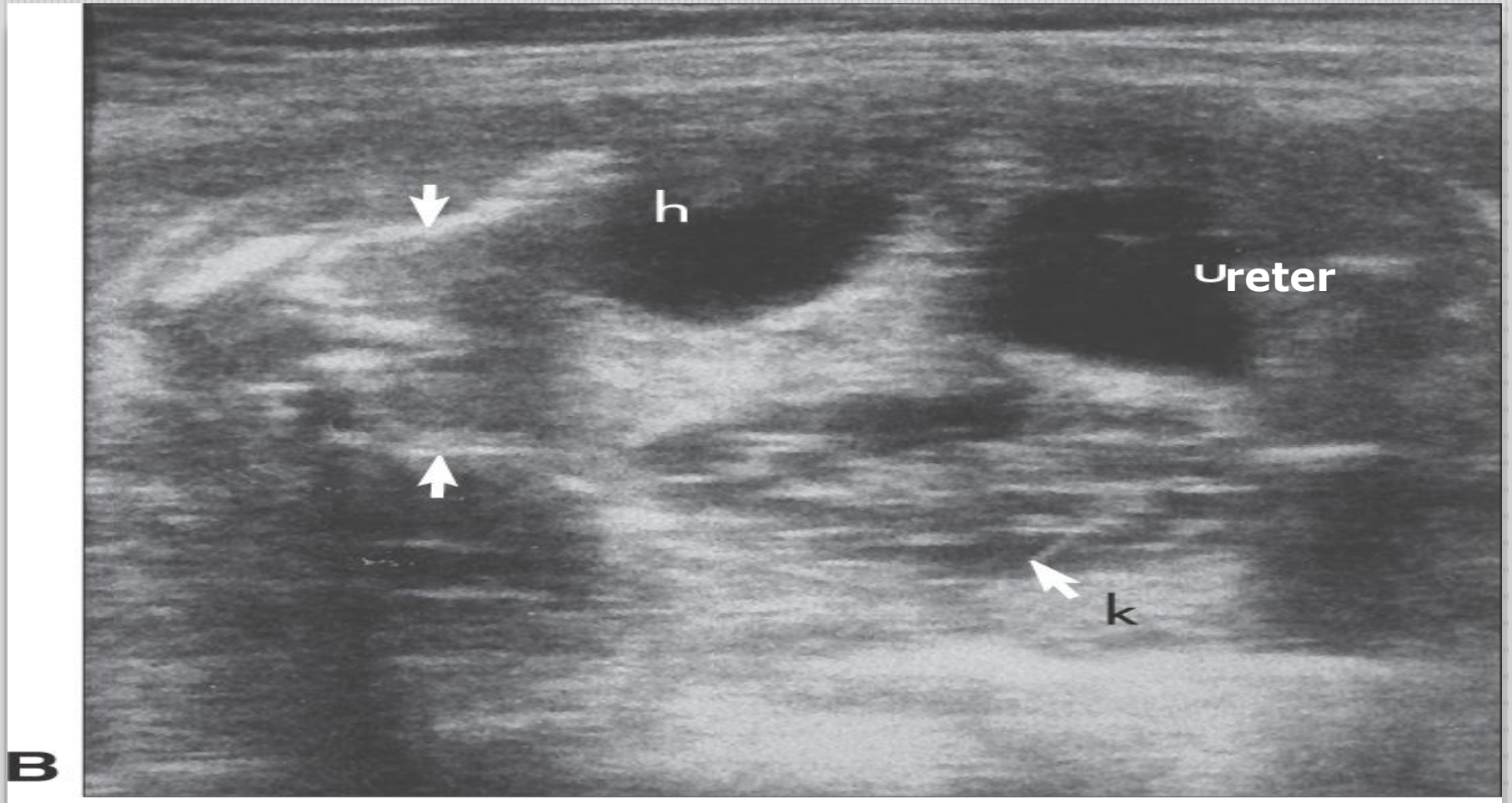
Renal Agenesis
Enlarged Adrenal Glands/
Absent Bladder



Infantile Polycystic Kidneys
Enlarged & Dense Kidneys



Posterior Urethral Valve Syndrome
Abnormally Distended Bladder



Small Thoracic Cavity (arrows)
Hydronephrosis/Hydroureter
Mild Hydro Contralateral Kidney

IUGR

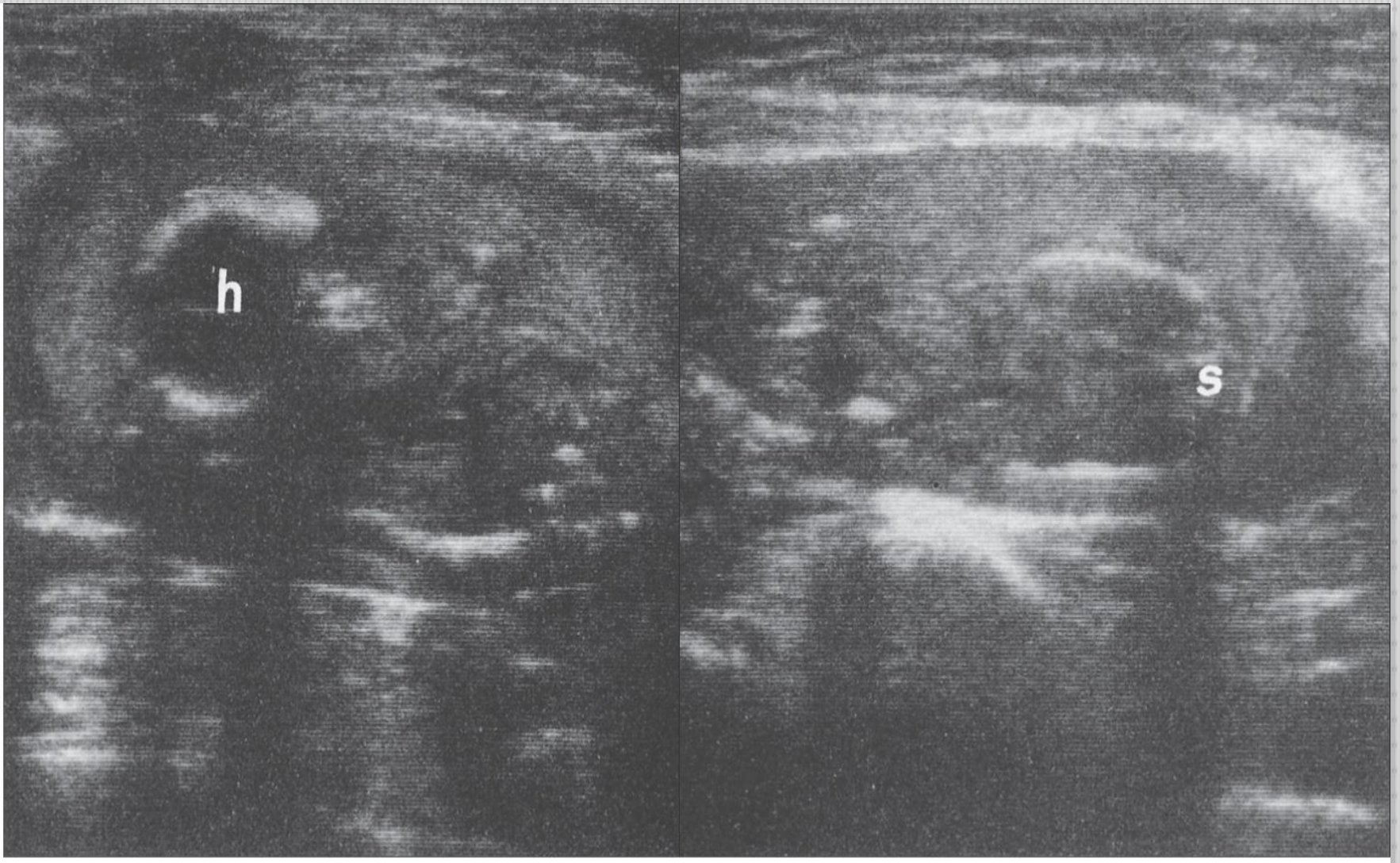
- Fetal hypoxemia (insufficient O2 in blood)may produce growth restriction and oligo
- 4X ⇧ risk of growth delay with oligo
- Placental insufficiency may cause IUGR
  - Produces redistribution of fetal blood flow away from the kidneys and toward the brain to counteract the hypoxia
    - Results in decreased urine output
      - Which decreases fluid volume

Post-term Pregnancies

- Oligo is a common complication
- Oligo associated with diminished placental function
  - Associated with the arterial redistribution of fetal blood flow with the brain-sparing effect

Ruptured Membranes

- Oligo may be observed as a consequence of CVS
- Persistent oligo in the second trimester carries a poor prognosis
  - Regardless of cause
- Less than 25 weeks
  - Severe oligohydramnios with a single pocket < 1 cm lasting 14 days after premature ruptured membranes
    - Associated with a high mortality rate



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16 wks

Iatrogenic Cause

- **Include**
  - **Medications**
    - **Nonsteroidal anti-inflammatory drugs**
    - **Angiotensin-converting enzyme inhibitors**
    - **Calcium channel blockers**
    - **Nitrous oxide**
  - **Insensible fluid loss and maternal intravascular fluid depletion**
  - **Prior procedures like CVS**

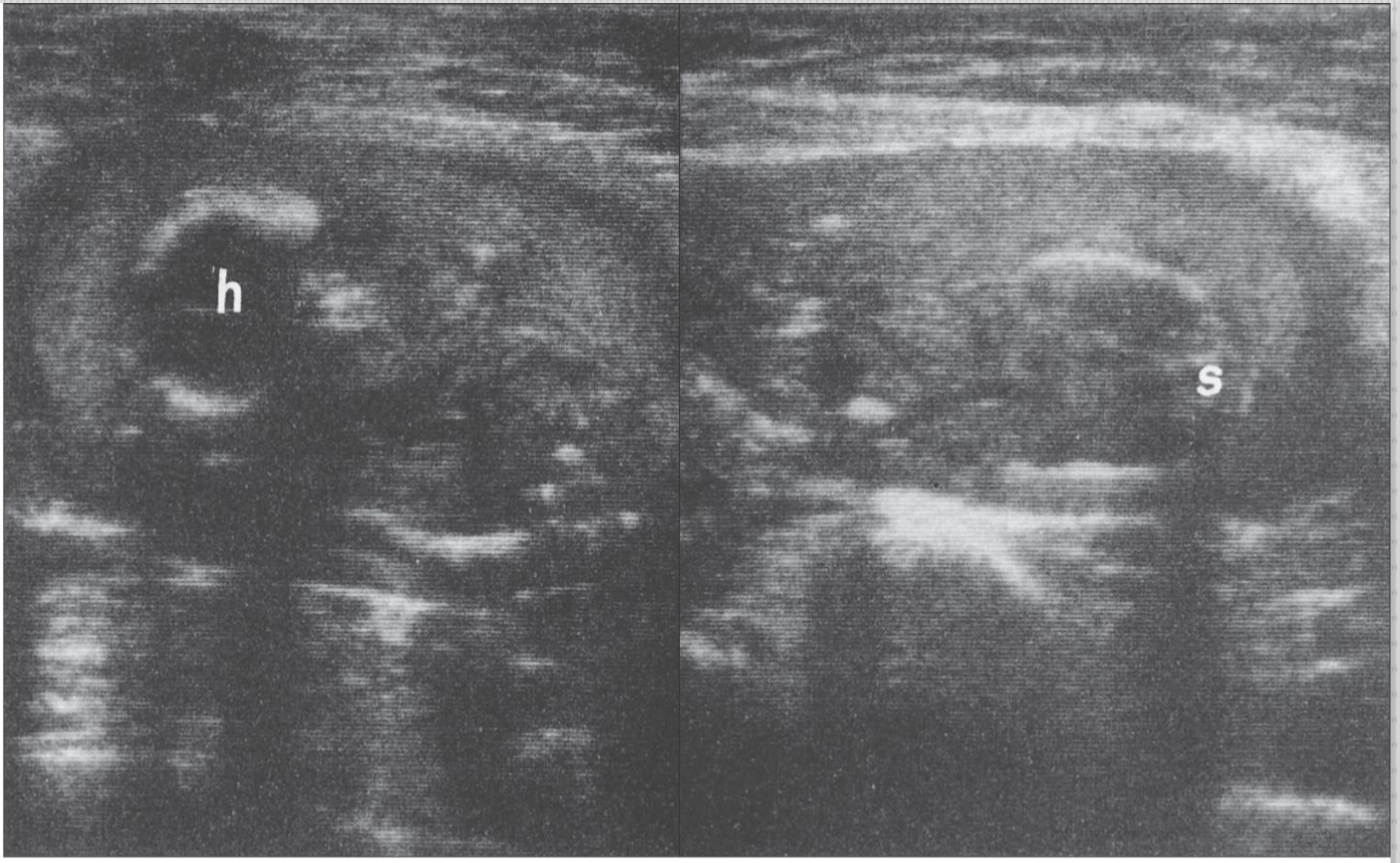
Prognosis

- Maternal hydration can improve amniotic fluid for patients with oligohydramnios
- If fetal anomalies or premature ruptured membranes are present
  - Maternal hydration will have little effect

Sonographic Findings

- **Poor scanning resolution is common**
  - **Limited anatomy surveys should be expected**
- **Evaluate blood flow with color and Doppler**
  - **Umbilical cord**
  - **Placenta**
  - **Cerebral vascular system**

****Critical for detecting the presence of IUGR***



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16 wks

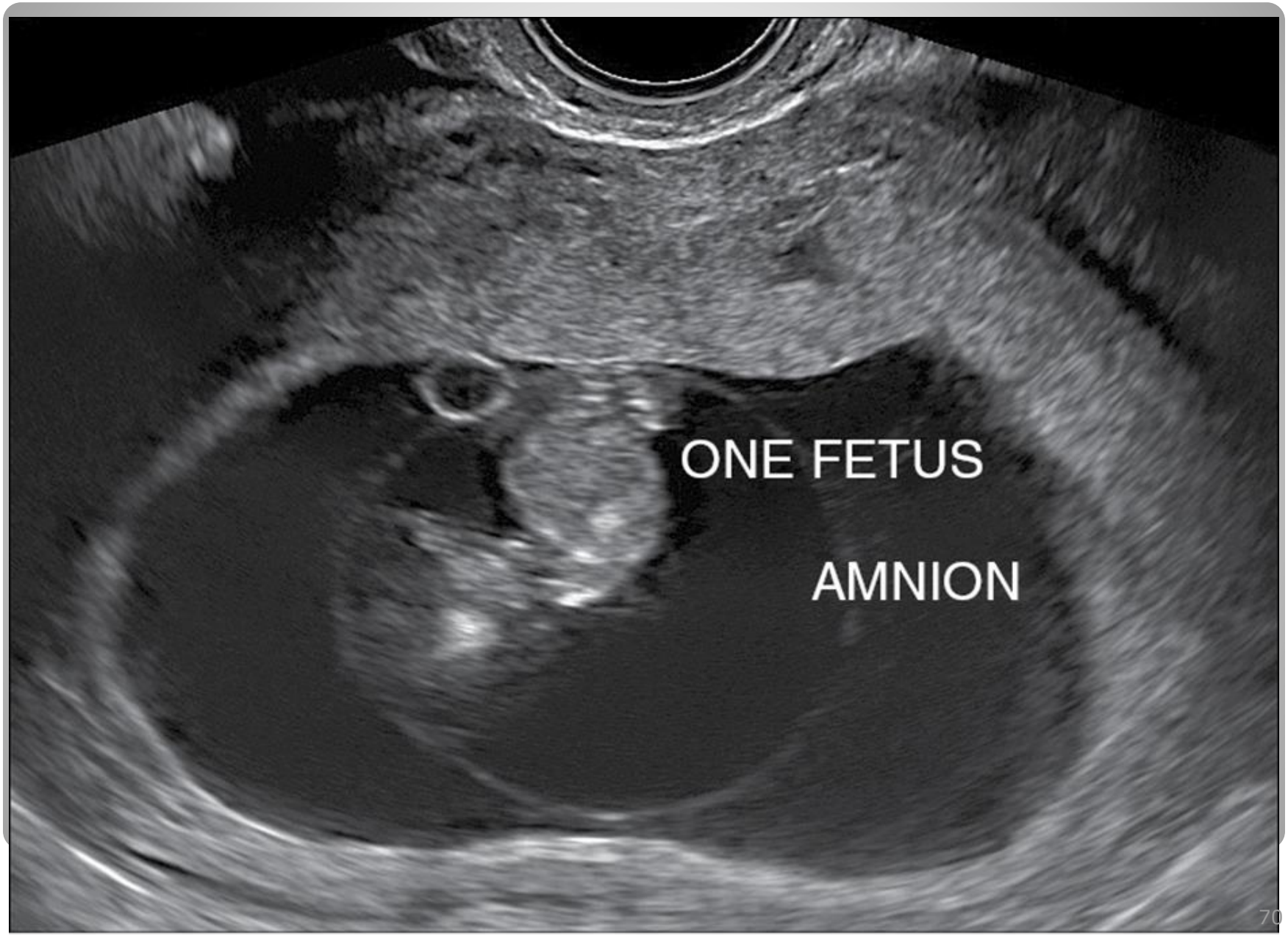
Sonographic Findings

- Cord compression by the fetus
  - Causes fetal asphyxia leading to oligo
- May see signs of mild cord compression
  - With cardiac decompensation
  - Changes in Doppler flow patterns
- Slight rotations of the mother may stimulate the fetus to roll away from the cord
  - Restoring blood flow

Ruptured Fetal Membranes

Ruptured Fetal Membranes

- Strength of the chorioamniotic membrane is determined by the cellular makeup
- Under normal conditions, the membranes rupture due to normal cell death and mechanical forces



Ruptured Fetal Membranes

- Membranes normally rupture after onset of labor
- If membranes rupture abnormally:
  - Premature rupture of membranes (PROM)
  - Preterm premature rupture of membranes (PPROM)
  - Spontaneous rupture of membranes (SPROM)

Ruptured Fetal Membranes

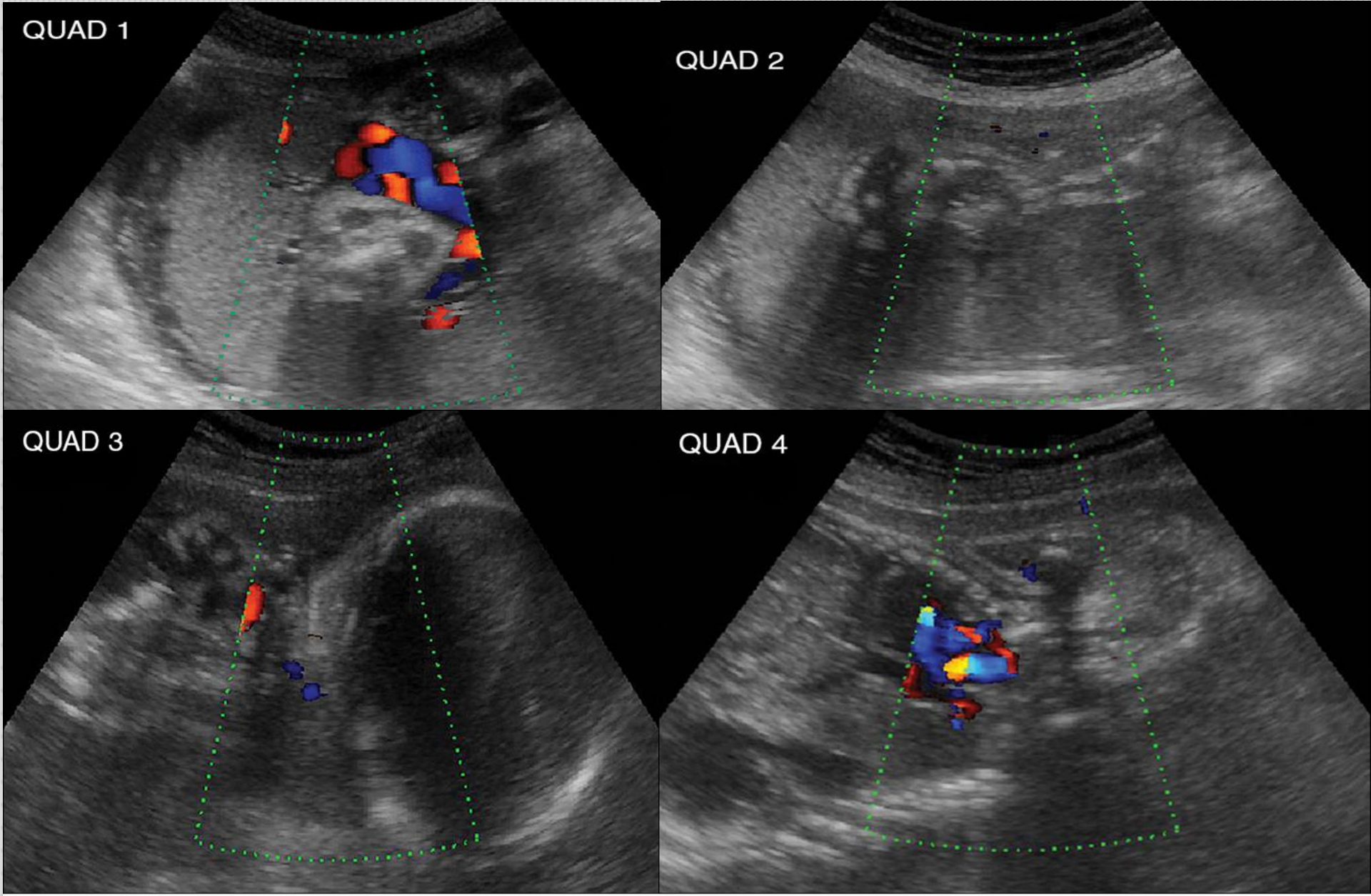
- **Patient presenting with ROM have a sudden gush or leaking of fluid**
  - **"water breaking"**
- **Nitrazine paper and fern paper test determines presence of AF in vaginal secretions**

Ruptured Fetal Membranes

- Prognosis of fetus affected by abnormal ruptured membranes depends on fetal GA, fetal status, and ability to control uterine contractions
- Abnormal ROM associated with:
  - Preterm delivery
  - Fetal and neonatal death
  - Neonatal respiratory distress
  - Prolapsed umbilical cord
  - Chorioamnionitis
  - Placental abruption

Ruptured Fetal Membranes

- **Sonography is used to document the integrity of the placenta, fetal size, AF volume, fetal well-being and to perform fetal Doppler studies**
  - **Biophysical profile**
- **Placental abruption is associated with ROM**
  - **Make sure to fully evaluate the retroplacental space**



C

D

Ruptured Fetal Membranes

Amniotic Band Syndrome

Amniotic Band Syndrome

- Associated with abnormality in fetal membranes
- Common, nonrecurrent cause of various fetal malformations involving:
  - Limbs
  - Craniofacial region
  - Trunk

Amniotic Band Syndrome

- **Most widely accepted theory is rupture of amnion during early pregnancy development leads to subsequent entanglement of various embryonic or fetal parts**
- **May cause lymphedema, amputations, slash defects**

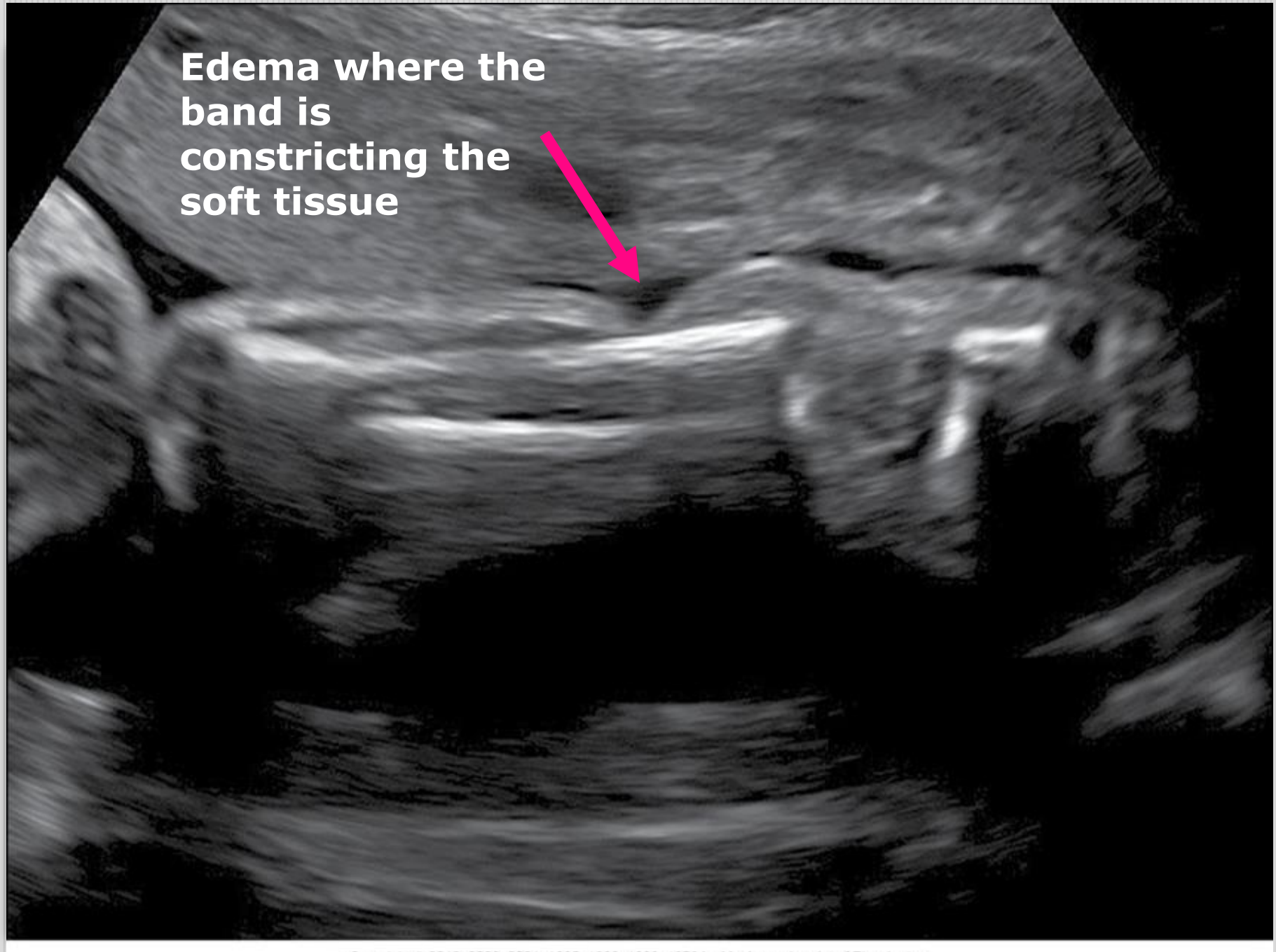
Amniotic Band Syndrome

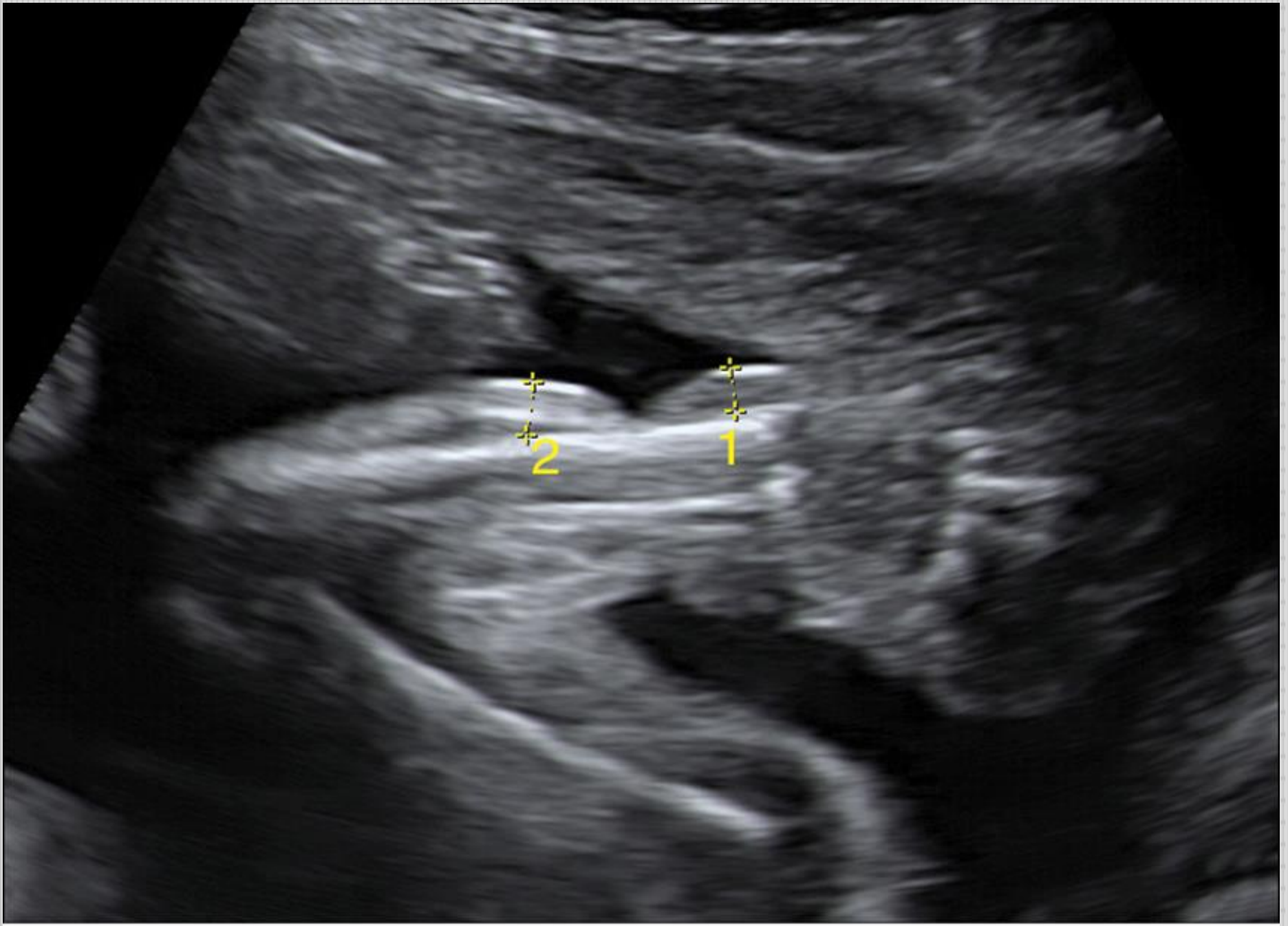
- **May represent a milder form of limb–body wall complex**
- **May be predicted by amniotic bands (fibrous tissue strands) that entangle or amputate fetal parts**

Amniotic Band Syndrome

- **Common findings**
  - **Facial clefts**
  - **Asymmetric encephaloceles**
  - **Constriction or amputations defects of the extremities**
  - **Clubfoot deformities**

A





Amniotic Band Syndrome

- Site where the amniotic band cuts across the fetus is evident after birth
- As the rupture enlarges
  - Amniotic fluid and fetus exit through it into the space between the amnion and chorion
    - The collapsed amnion is dragged along behind and becomes the destructive band

Amniotic Sheets and Synechiae

- **Believed to be caused by uterine scars (synechiae)**
  - **C-sections**
  - **D&C**
  - **Episodes of endometritis**

Amniotic Sheets and Synechiae

- Amniotic sheets
  - Fine echo-dense line in the uterine cavity separated from the uterine wall by an echolucent space
  - Membrane
    - May surround fetus
    - May be freely mobile in the amniotic cavity
  - Does not place fetus at risk for malformations

Uterine Synechiae

Hydrops Fetalis

- **Disparity is seen between the amount of serous fluid being produced and that of which is absorbed**
  - **Leads to the accumulation of fluid within a fetus in <u>at least 2 areas</u>**
    - **Pleural effusions**
    - **Ascites**
    - **Cardiac effusions**
    - **Skin edema**
    - **Anasarca**

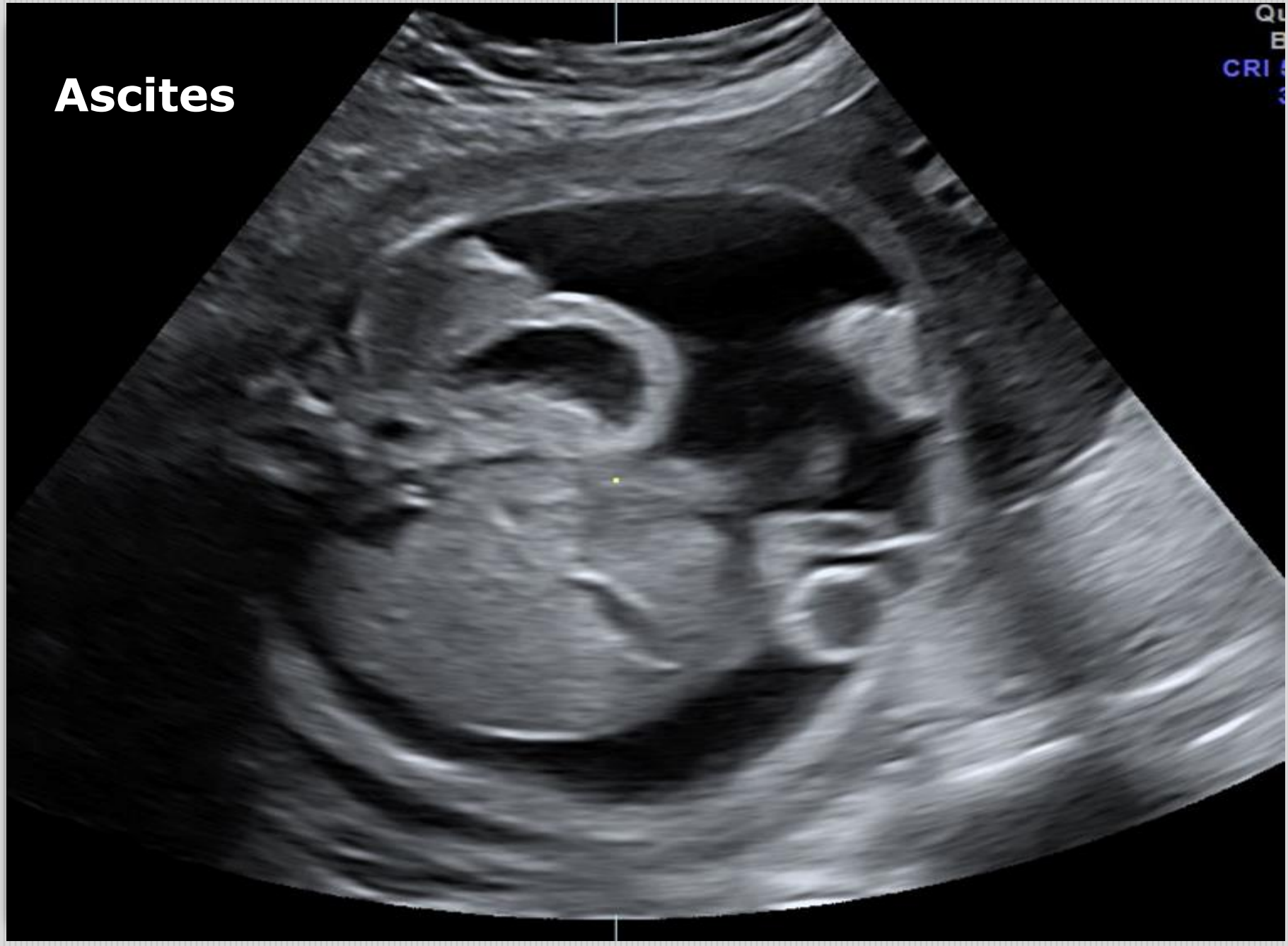
Hydrops Fetalis

- Other sonographic findings may include enlarged umbilical cord, polyhydramnios, placental edema and an enlarged liver or spleen
  - High incidence of mortality
- Affects fetus and mother
- Categorized as immune and non-immune related

Hydrops Fetalis

- **Ascites: anechoic fluid collections within the abdominal and pelvic cavities**
  - **Common site of early accumulation - umbilical cord insertion**
- **Pleural effusions: anechoic fluid surrounding the lungs or confined to the thorax**
- **Skin edema: increased skin thickening around skull, neck, abdomen or extremities**
  - **Greater than 5-6 mm thickness**

Ascites



Bilateral Pleural Effusions

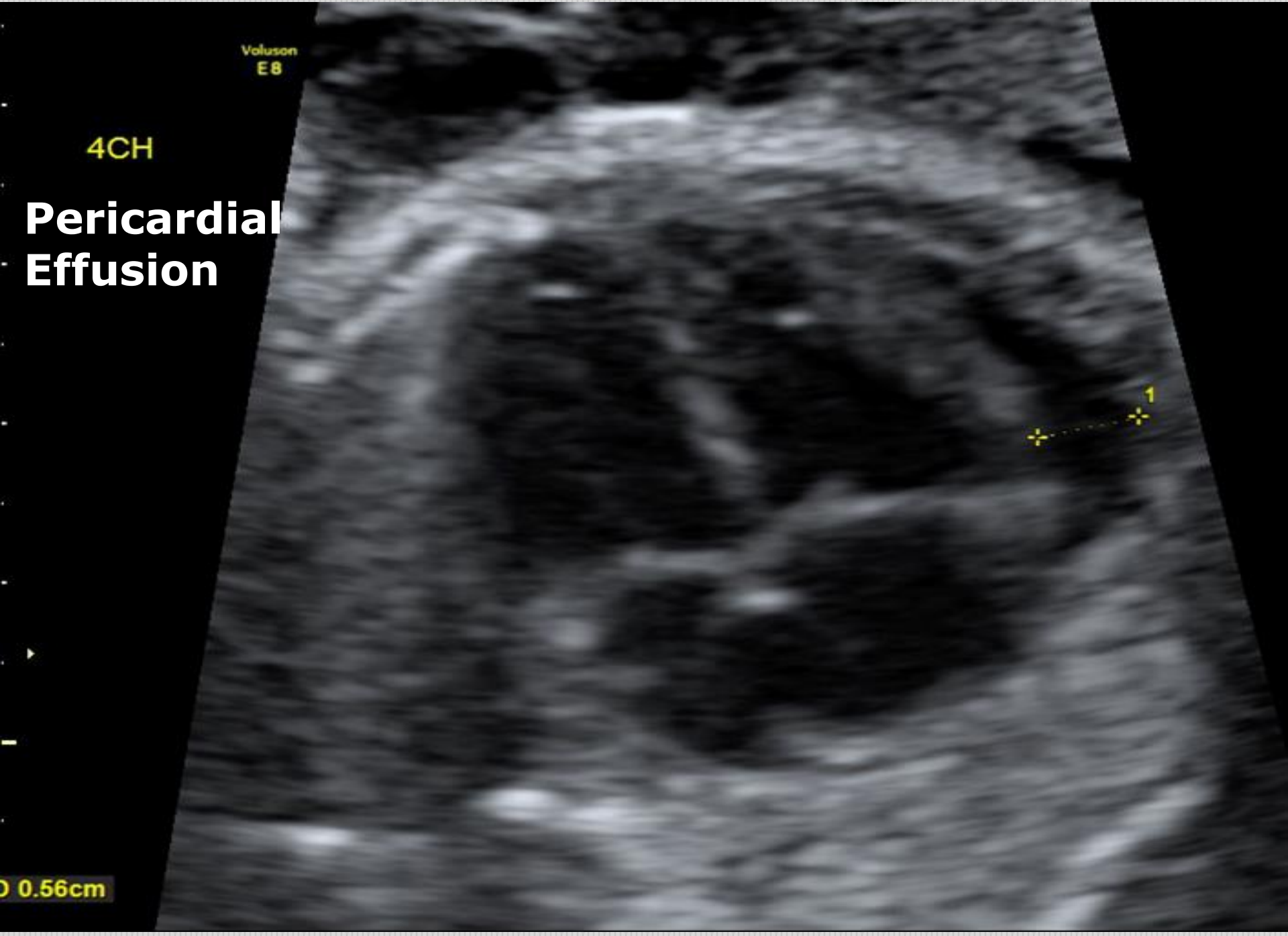
Skin Edema

A

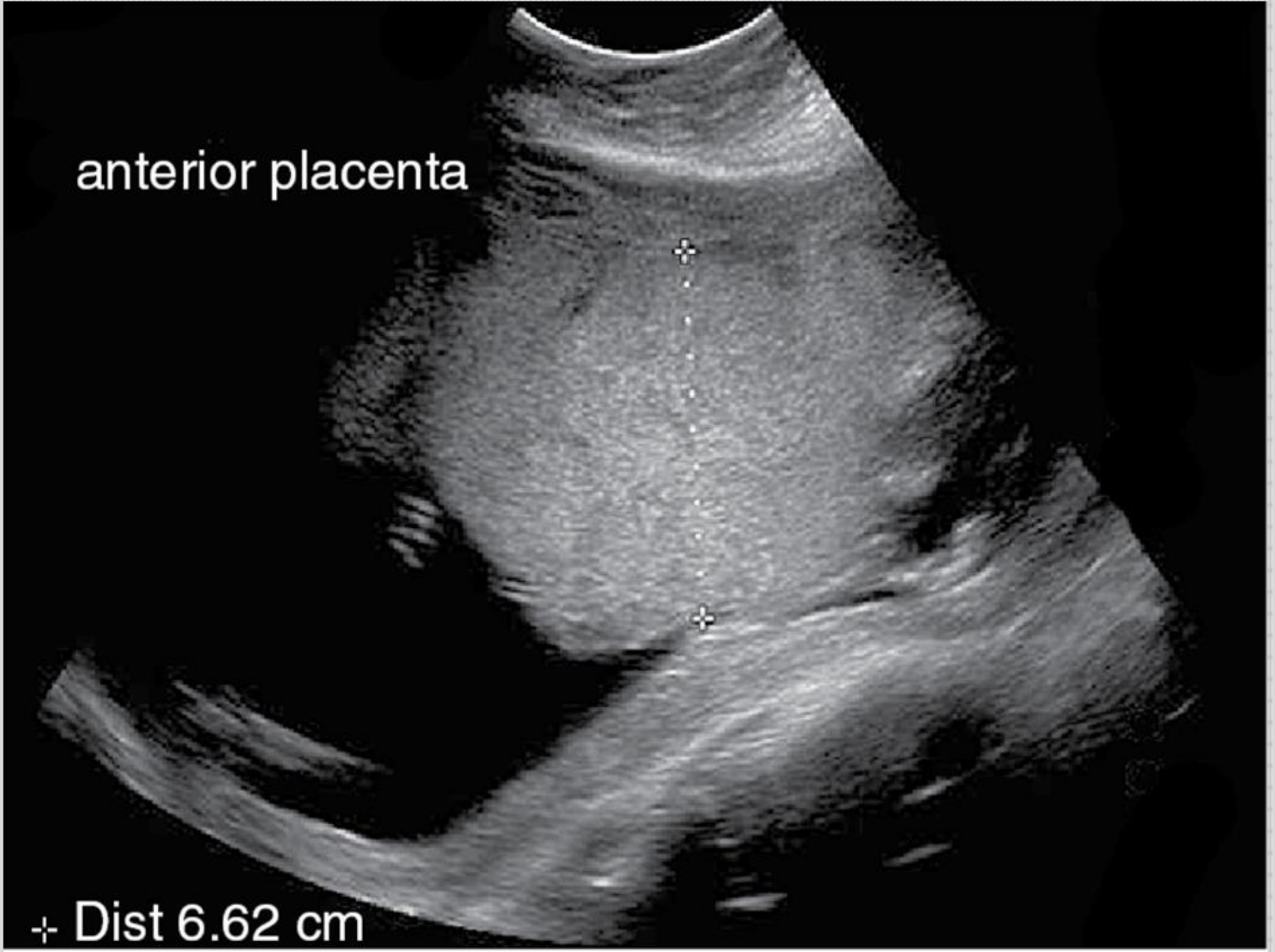
B

Hydrops Fetalis

- **Anasarca: massive skin edema encasing most of the body**
- **Pericardial effusion: excess anechoic fluid with in the pericardial cavity**
  - **Fluid collection measuring >2mm**
- **Placental edema: thickened placenta measuring more than 4-4.5 cm in the AP dimension**



Pericardial Effusion



Immune Hydrops

- **Immune hydrops fetalis (IHF) associated with**
  - **Rh isoimmunization**
  - **Erythroblastosis fetalis**
- **If maternal blood tests show a Rh-D negative blood grouping, they are at risk for attacking a fetus that is Rh-D positive**
  - **Antibodies being produced will lead to fetal anemia and eventually, immune hydrops**
- **Typically occurs with a second or subsequent pregnancy**

Immune Hydrops

- **Associated with high prenatal and perinatal morbidity**
  - **Treatment can include Rhogam (anti-D immunoglobin) injection around 28 weeks gestation or intrauterine blood transfusions**
- **Sonographic Findings:**
  - **Evaluate fetus for fluid collections**
  - **Doppler velocities of the Middle Cerebral Artery (MCA) and Aorta**
  - **Amniocentesis**
  - **Cordocentesis**

Nonimmune Hydrops

- Nonimmune hydrops fetalis (NIHF) may be sporadic or associated with numerous conditions
  - Most common cause: cardiac insufficiency
- Poor prognosis (50-98% mortality rate)
  - Percentage is related to etiology of hydrops
- Fetuses born with NIHF are typically distressed and require immediate medical attention

Nonimmune Hydrops

- Evaluate all abnormal fluid collections
- Evaluate for anomalies (fetal tumors, cardiac irregularities, cystic adenomatoid malformations [CAM] related to the lung)
- Any sonographic findings related to chromosomal abnormalities
  - Trisomy 21, 45X
  - TORCH