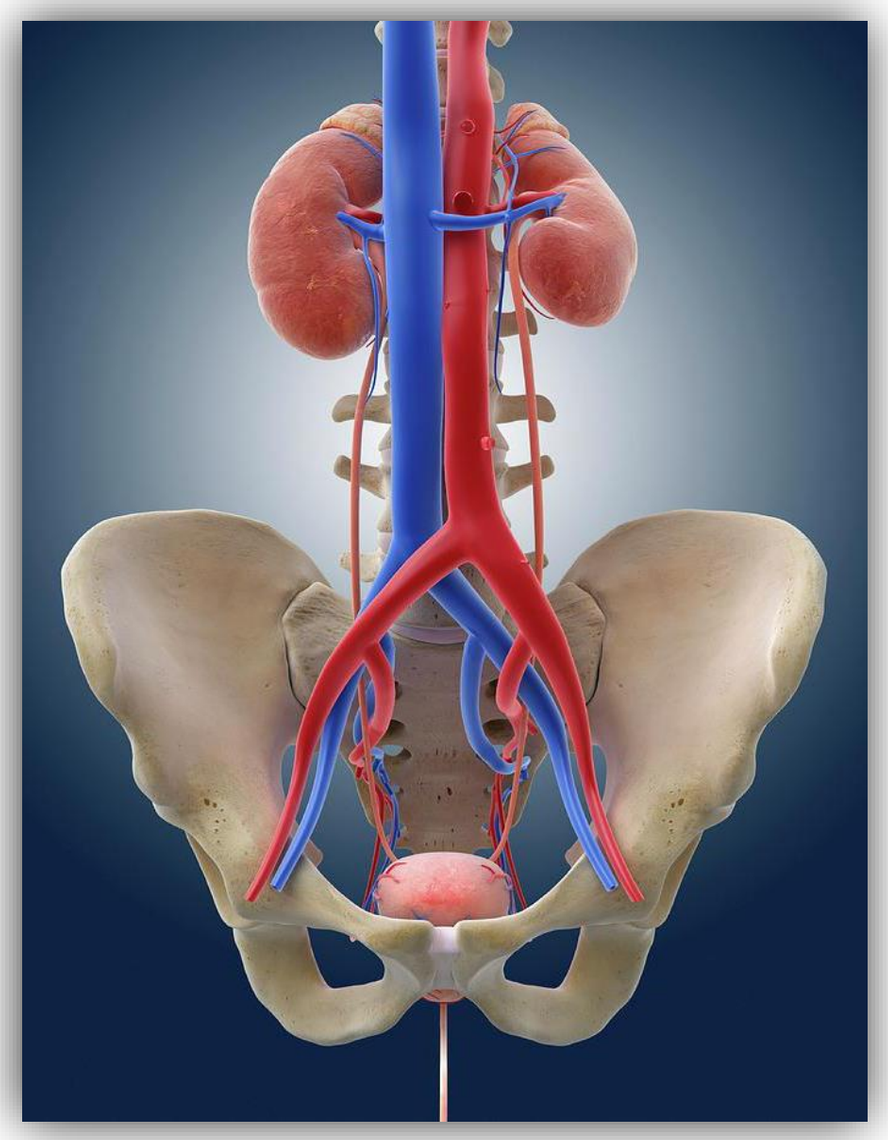
OB GYN SONOGRAPHY REVIEW

Fetal Genitourinary System

Course Outline

- Embryology
- Normal Sonographic Anatomy
  - Kidneys
  - Urinary bladder
  - Adrenal glands
  - Genitalia
- GU Abnormalities

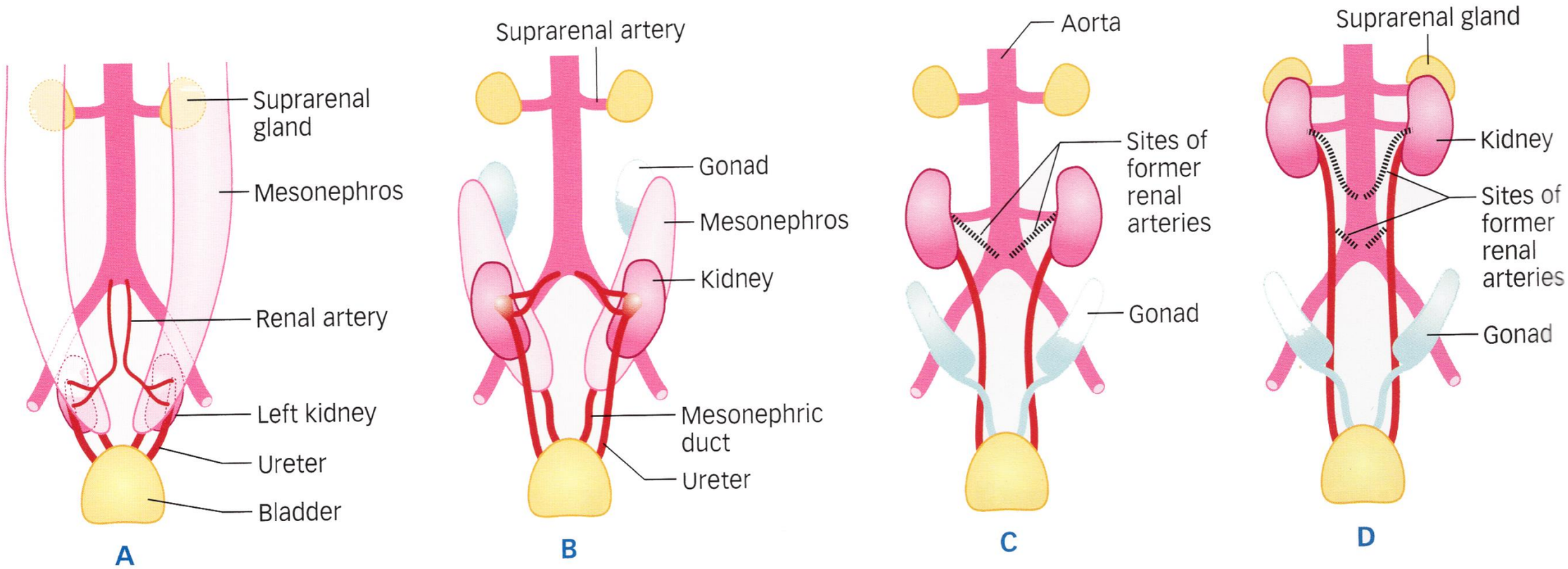


Embryology

Embryological Development

- GU systems arises from embryonic mesoderm at ≈6 weeks
- Three stages of development:
  - Pronephros
  - Mesonephros
  - Metanephrosis
- Ascend from pelvis into abdomen with arterial supply arising from different levels
- Fully developed by 9th menstrual week

FETAL GENITOURINARY SYSTEM



Embryonic (A-B)

Fetal (C-D)

Demonstrates how primitive kidneys rotate medially and ascend into the abdomen from the pelvis

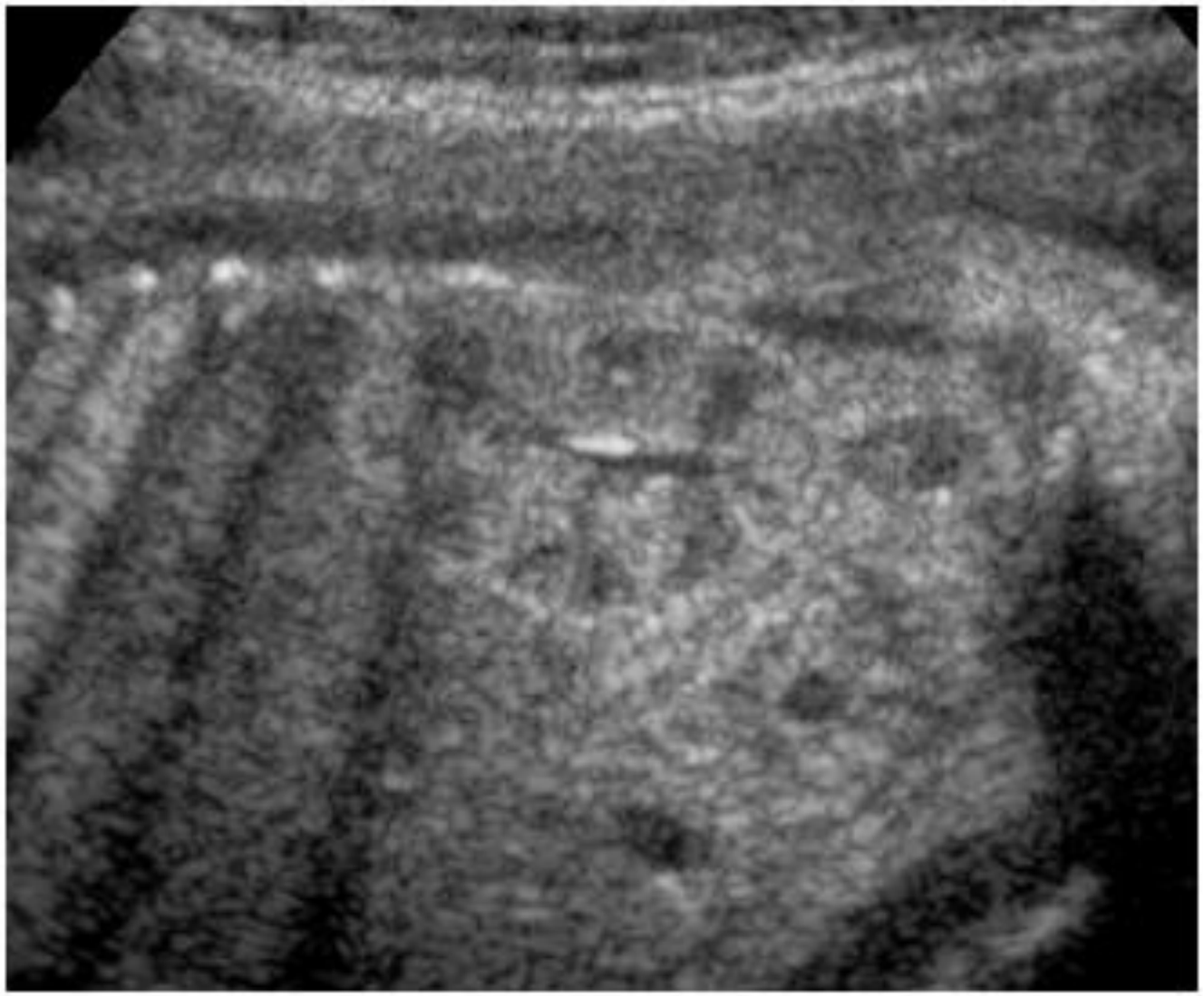
Normal Sonographic Anatomy

Kidneys

- Can be identified as early as 12 - 14 menstrual weeks
  - Best examined at 17 – 21 weeks
- Hypoechoic renal pyramids are radially arrayed throughout the parenchyma
- Renal sinus fat is more echogenic
- Small amount of fluid may be seen in renal pelvis

NORMAL SONOGRAPHIC ANATOMY - KIDNEYS

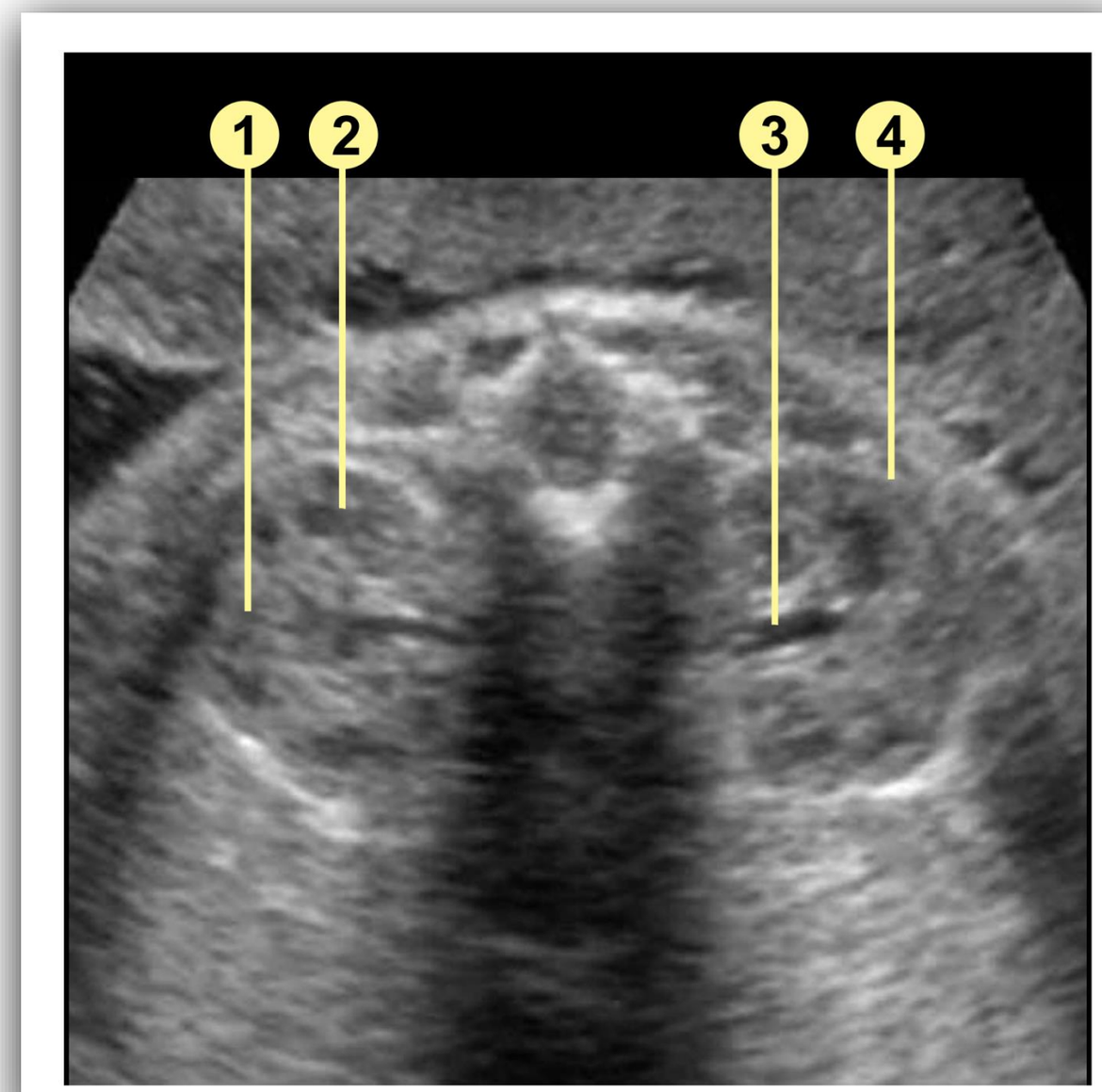
Sagittal



Renal pyramids arrayed around renal pelvis

NORMAL SONOGRAPHIC ANATOMY - KIDNEYS

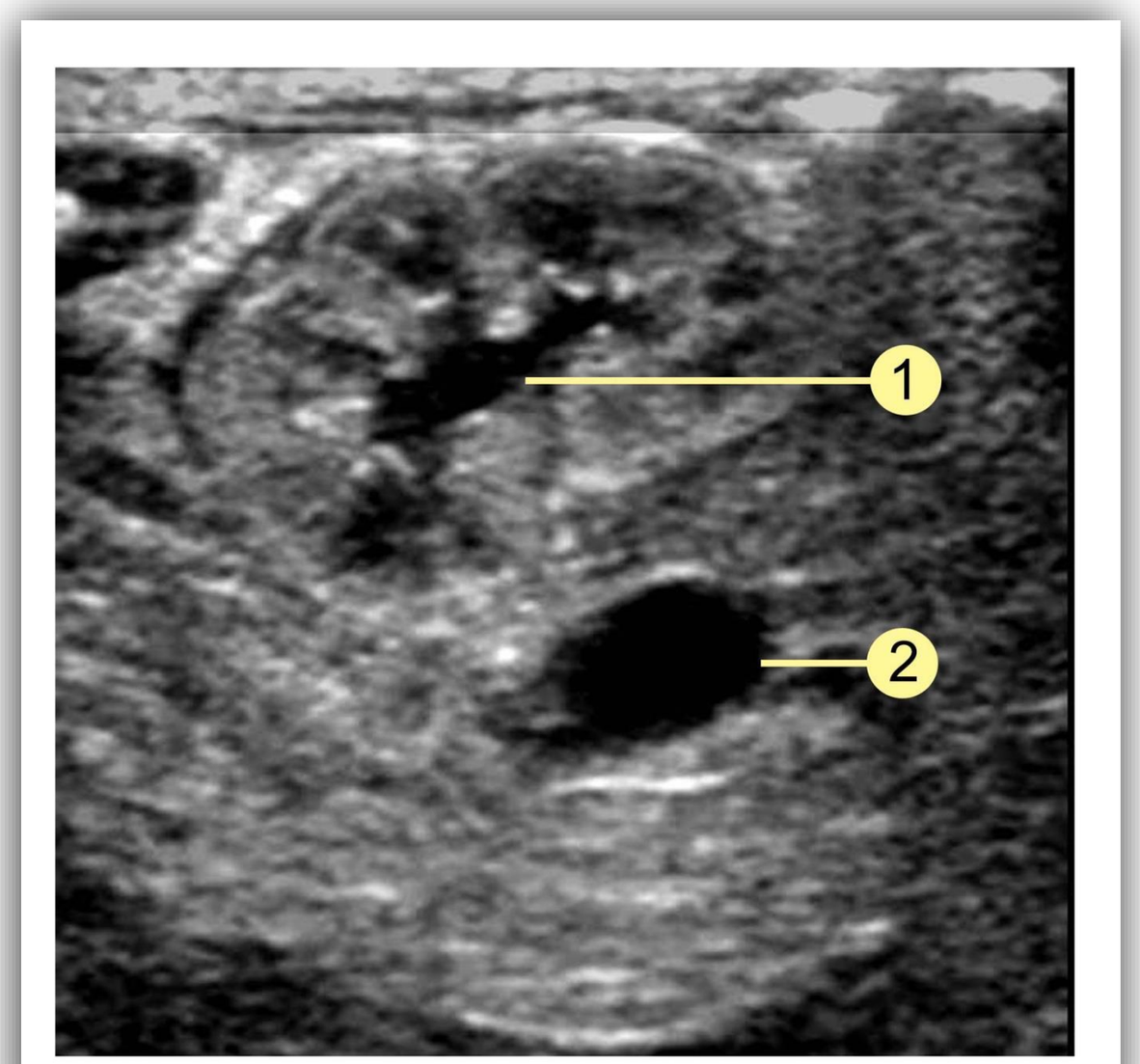
Transverse



1 = renal sinus
2 = renal pyramid
3 = renal pelvis
4 = renal capsule

NORMAL SONOGRAPHIC ANATOMY - KIDNEYS

Axial oblique



1 = renal pelvis fluid
2 = urinary bladder

FETAL GENITOURINARY SYSTEM

AP RENAL PELVIS MEASUREMENTS	
< / = 5mm	Normal
5 – 10mm	Probably normal, follow up
> / = 10mm	85% have anatomic anomaly

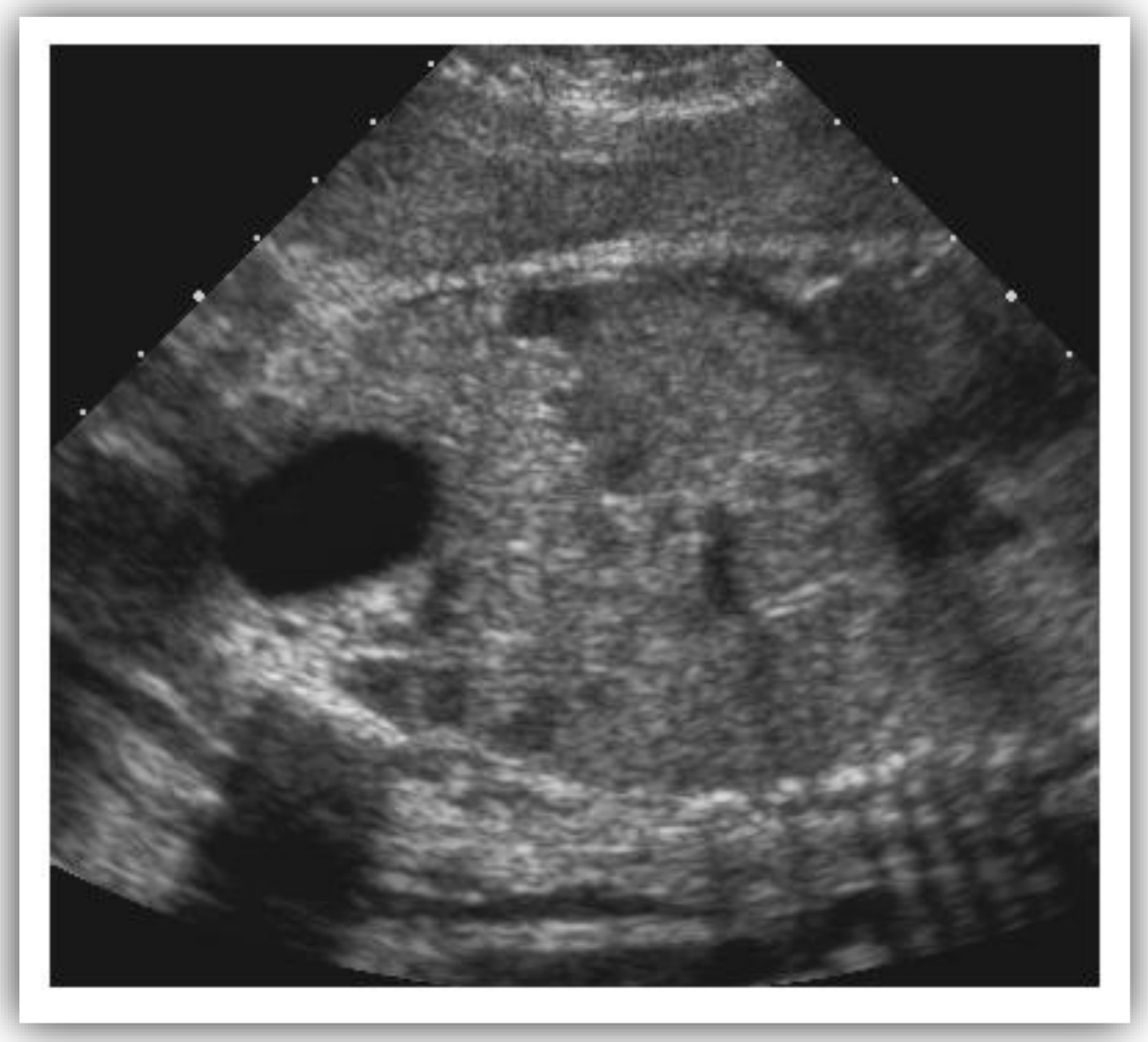
AGE RELATED RENAL PELVIS MEASUREMENTS	
Weeks	AP measurement (mm)
13 – 20	5
20 – 30	8
>30	10

Urinary Bladder

- Routinely identified by 20 menstrual weeks
- Indicator of renal function
- Empties and fills in the normal fetus on 30 – 45-minute cycles
  - Absence on initial exam should be rechecked later
- Midline, anechoic pelvic structure
- Iliac vessels, run posterolateral to bladder and can be identified with CDI

NORMAL SONOGRAPHIC ANATOMY – URINARY BLADDER

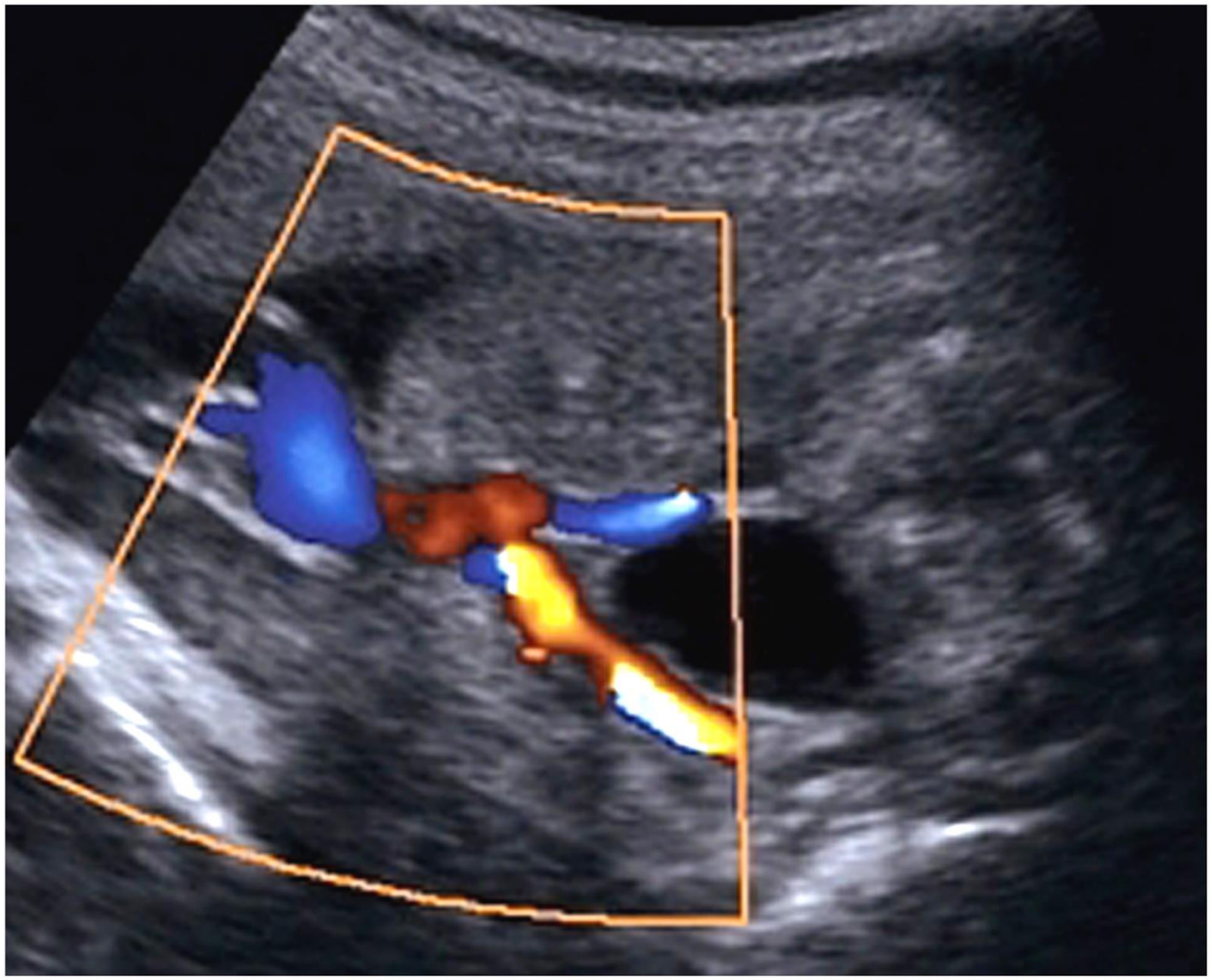
Coronal



Bladder seen as anechoic midline structure in pelvis

NORMAL SONOGRAPHIC ANATOMY – URINARY BLADDER

Axial oblique



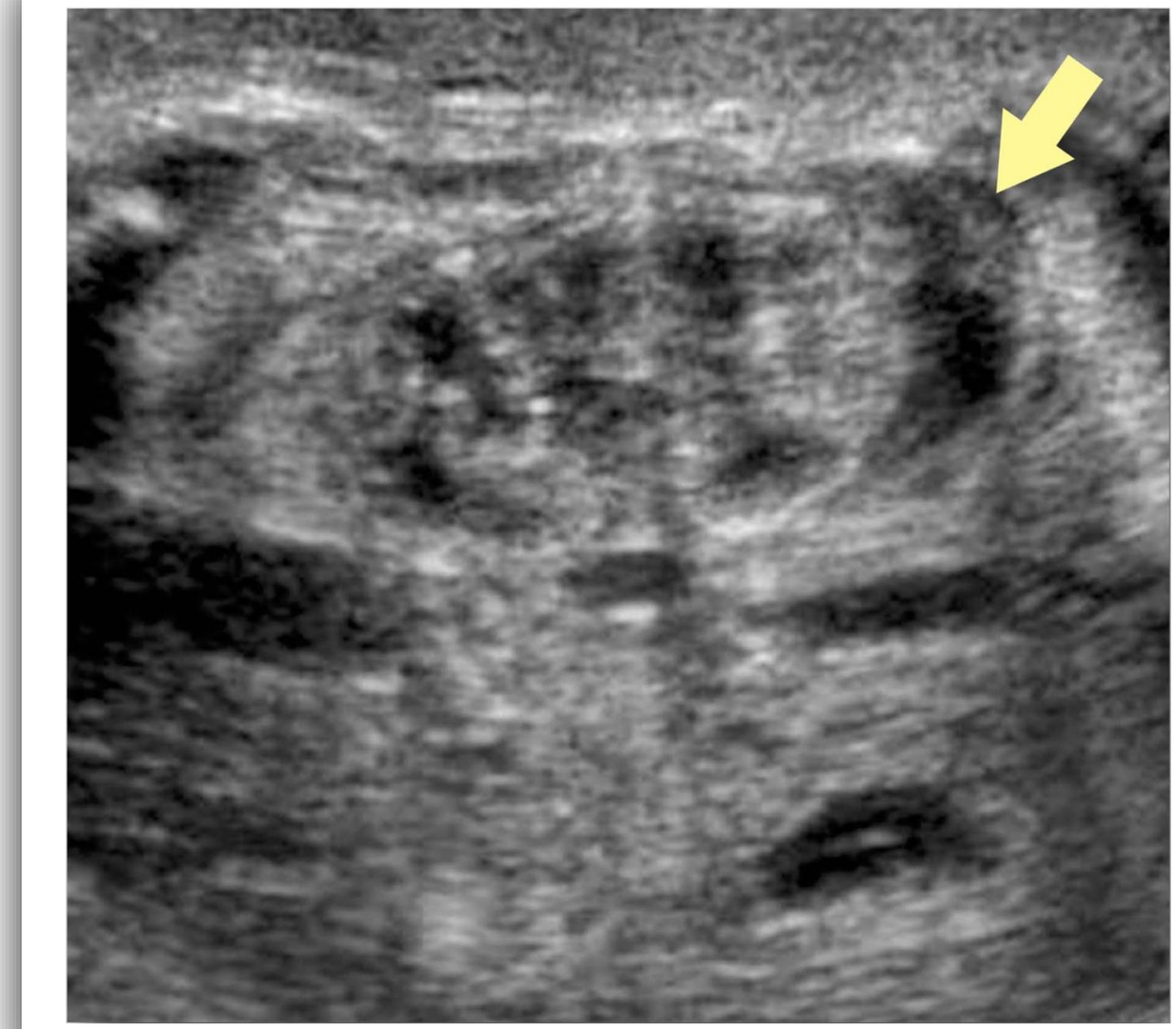
Paired iliac vessels coursing around fetal bladder

Adrenal Glands

- Adrenal glands relatively large in the fetus
- *Sagittally:* seen as ovoid masses superior to the kidneys
- *Transversely*: they appears as long, thin echogenic lines of medulla surrounded by thicker hypoechoic rims of cortex
- Composed of 90% cortex which quickly involutes after birth

NORMAL SONOGRAPHIC ANATOMY – ADRENAL GLANDS

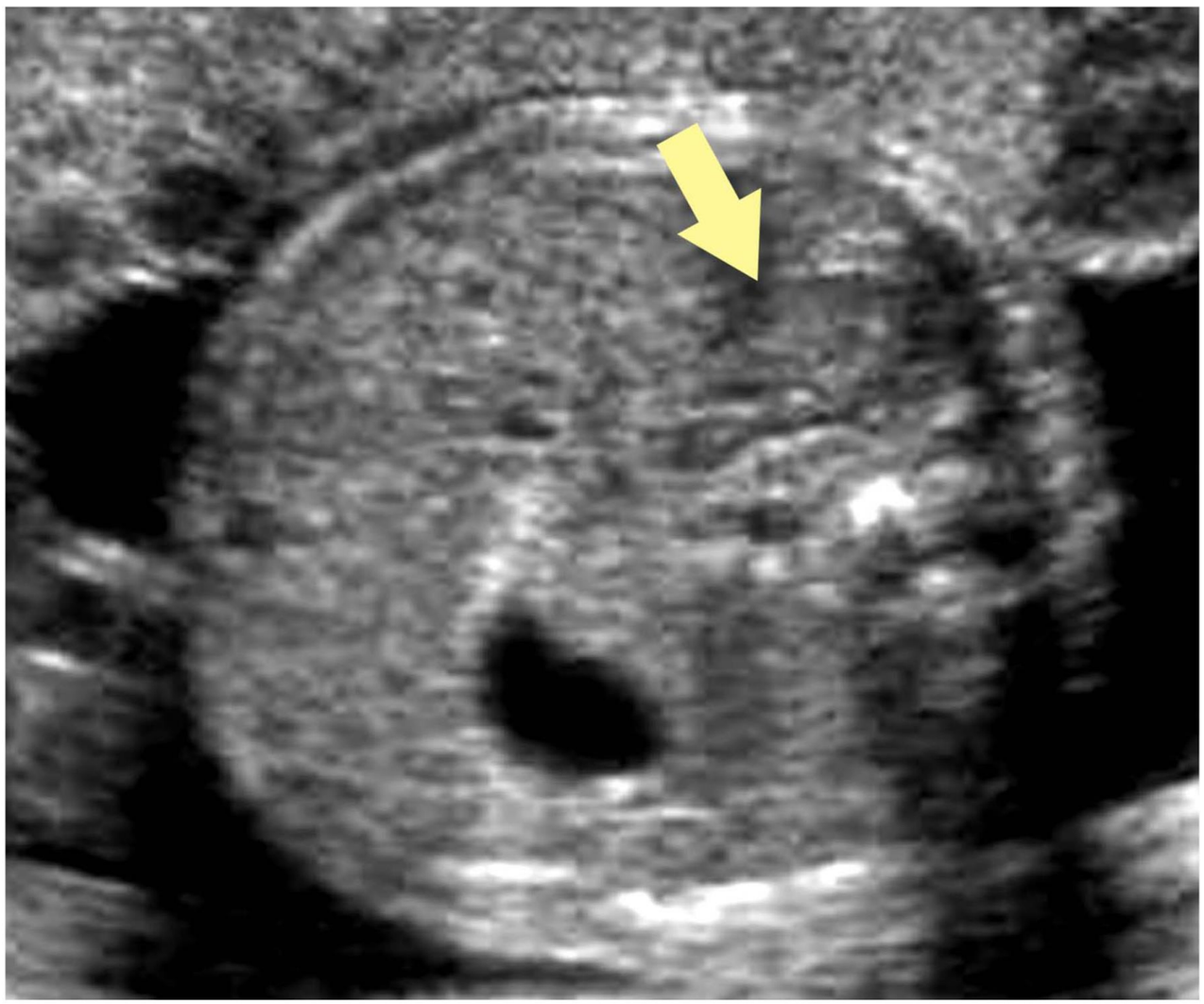
Sagittal



Arrow = ovoid mass superior to kidney

NORMAL SONOGRAPHIC ANATOMY – ADRENAL GLANDS

Transverse

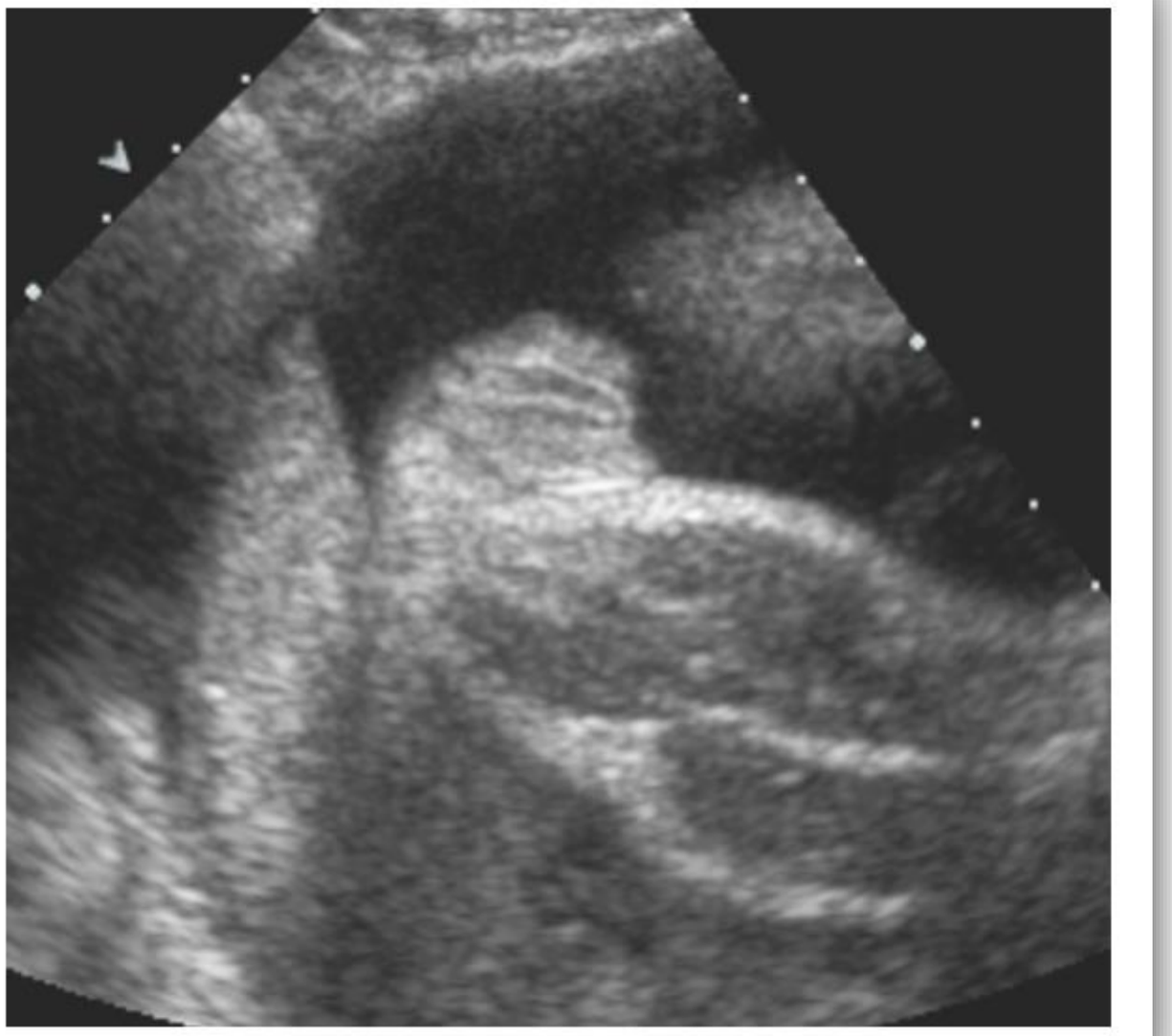


Arrow = thick hypoechoic cortex

Genitalia

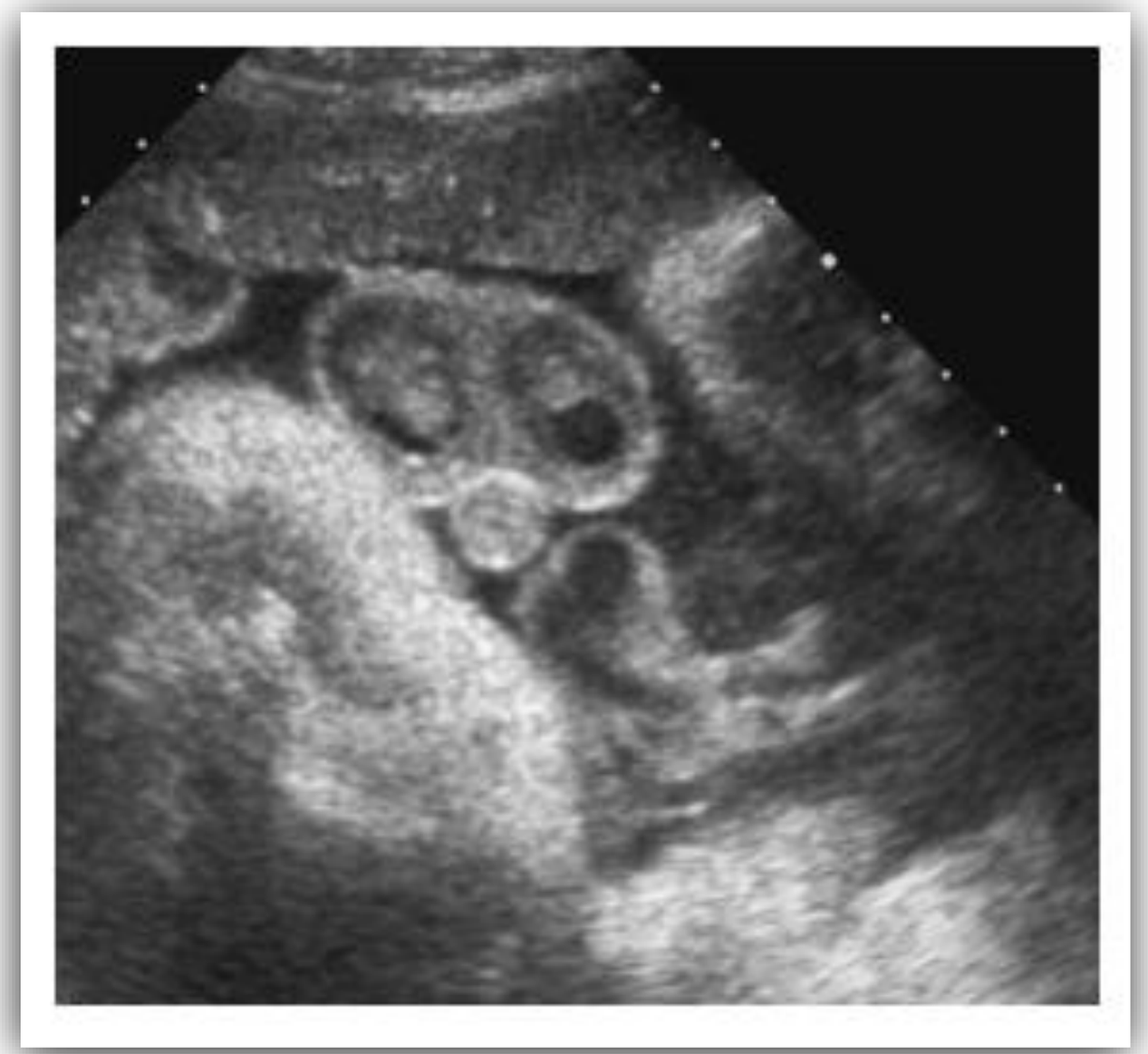
- May be evaluated to assist in differential diagnosis of GU anomalies and chromosomal syndromes
- Can be sonographically identified in virtually all normal pregnancies
  - Can be differentiated as early as 12 weeks
  - Can *reliably* be determined by 18 – 20 weeks
- *Male*: penis and scrotum in perineum
- *Female*: three, parallel linear echoes representing labia majora

NORMAL SONOGRAPHIC ANATOMY – GENITALIA



Female – labia majora

NORMAL SONOGRAPHIC ANATOMY – GENITALIA

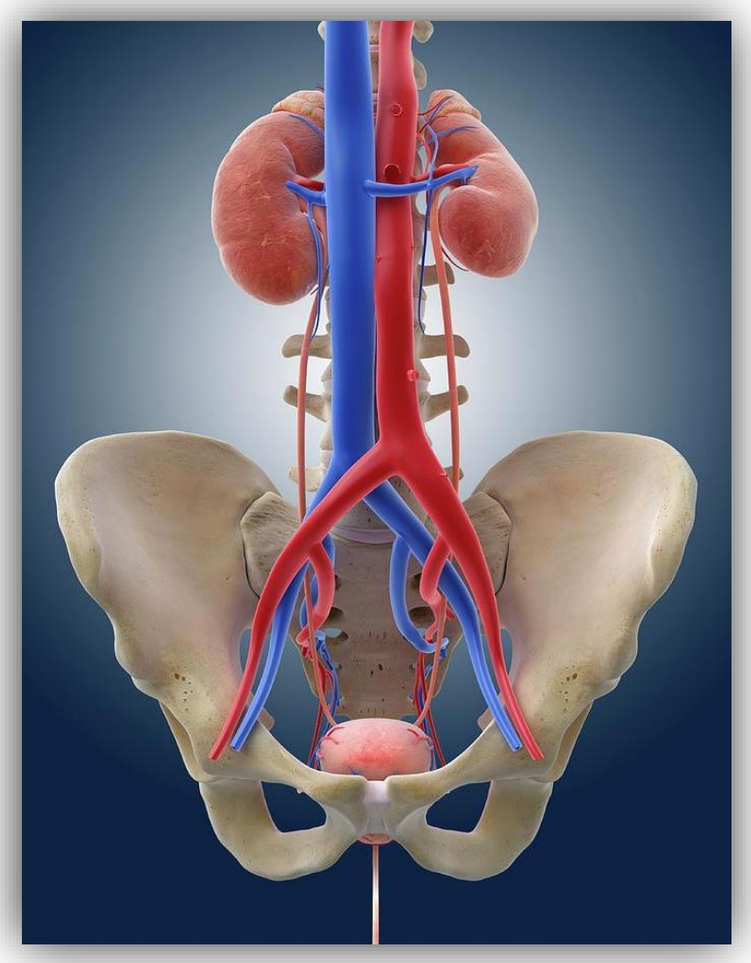


Male – penis and scrotum

GU Abnormalities

Categories of GU Abnormalities

- Excretory components
  - Renal agenesis
  - Renal cystic disease
  - Obstructive uropathies
  - GU neoplasms
- Reproductive components
  - *Rarely diagnosed in utero*
  - Genital agenesis/dysmorphia
  - Ambiguous genitalia
  - Others



Renal Agenesis

- Condition characterized by absence of one or both kidneys
- Etiology is unknown but believed to by multifactorial
- Results from failure of metanephros to develop in the embryo
- Both unilateral and bilateral associated with Potter sequence

Renal Agenesis - Unilateral

- 3 -4 times more common than bilateral
- Found in autopsy in ≈ 1 : 1000 individuals
- Most live without knowing they are absent a kidney
- If *in situ kidney* functions properly, no reason to suspect

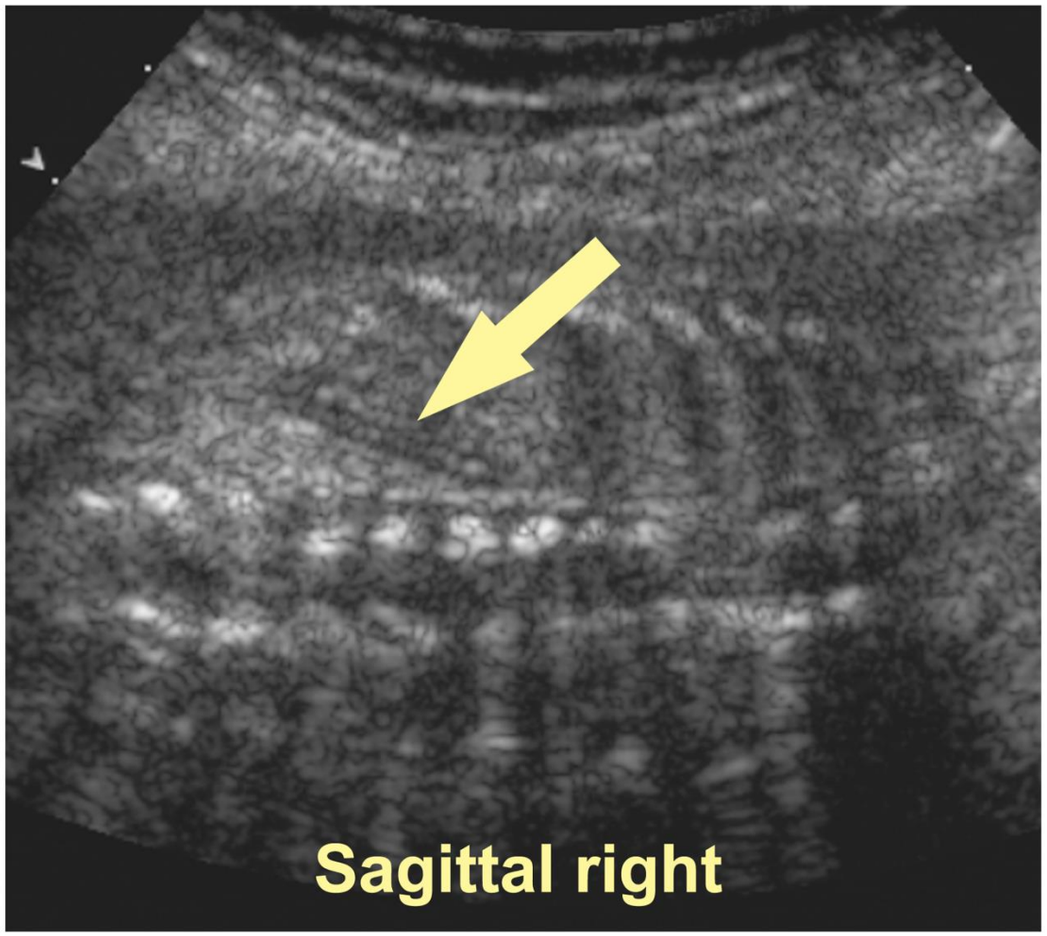
Renal Agenesis - Unilateral

- Associated abnormalities include:
  - Trisomy 21 (Down syndrome)
  - Turner syndrome
  - Potter sequence
  - Mullerian duct anomalies
  - Congenital heart disease
  - Obstructive uropathies
  - VACTERL association
  - Sirenomelia

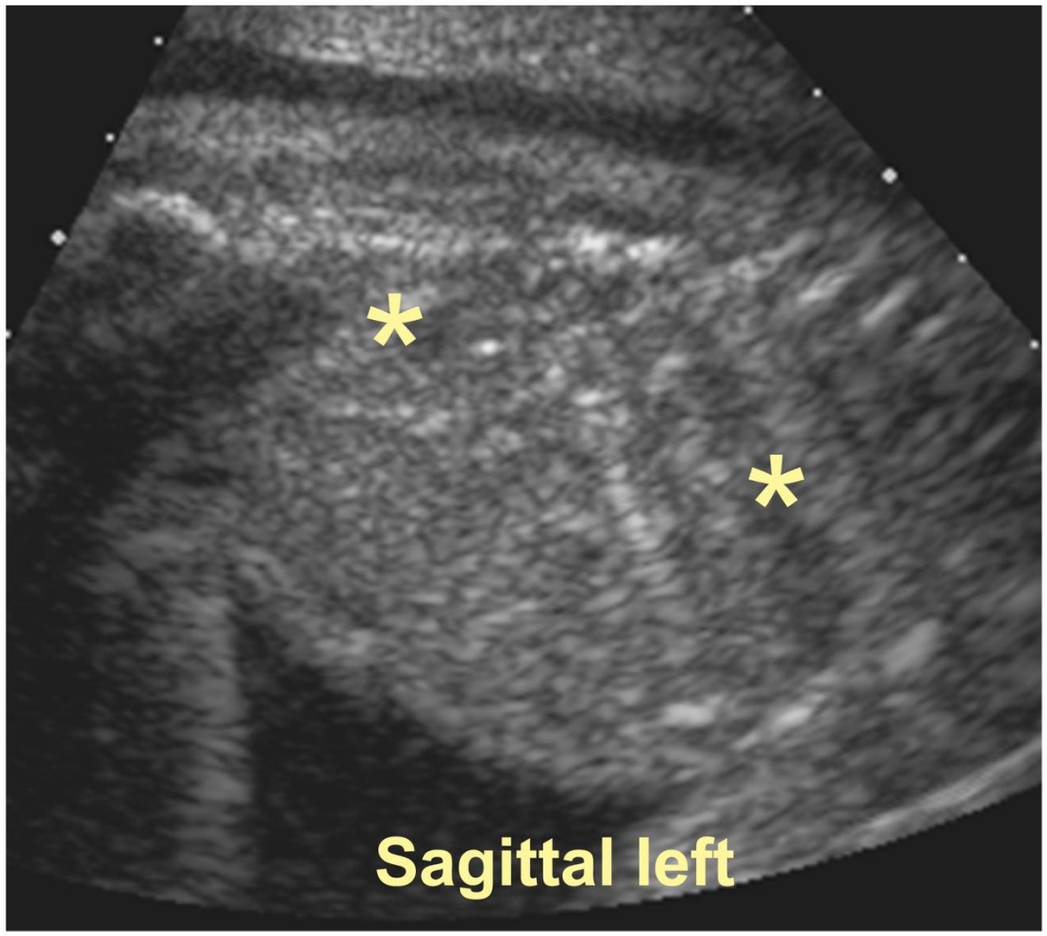
Renal Agenesis - Unilateral

- Sonographic findings include:
  - Absent kidney
  - Compensatory hypertrophy of contralateral kidney
  - Opportunistic hypertrophy of ipsilateral adrenal gland
  - Normal filling of urinary bladder
  - Normal amount of amniotic fluid

RENAL AGENESIS - UNILATERAL



Arrow = absent kidney with adrenal gland in renal fossa



Cursors = compensatory hypertrophy

Renal Agenesis - Bilateral

- Uniformly lethal condition characterized by congenital absence of both kidneys
- Can occur as an isolated phenomenon or as part of a syndrome
- No urine production at any time during pregnancy
- Fetal lungs fail to develop and postnatal demise is due to severe pulmonary hypoplasia

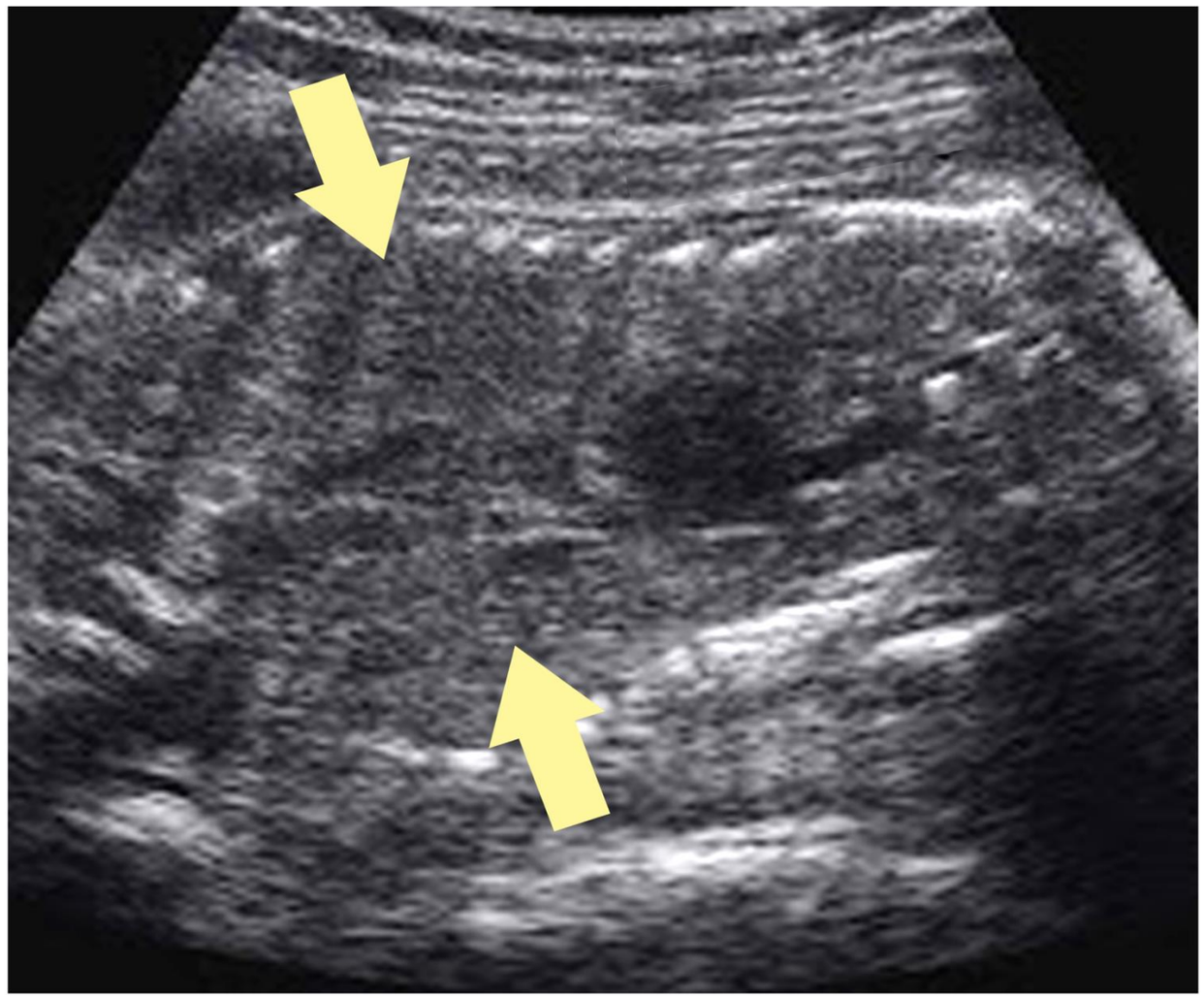
Renal Agenesis - Bilateral

- Associated abnormalities include:
  - Potter sequence
  - Genital malformations
  - Sirenomelia
  - Cardiac anomalies (full range)
  - CNS anomalies (many)
  - GI anomalies (many)

Renal Agenesis - Bilateral

- Sonographic findings include:
  - Empty renal fossae bilaterally
  - Oligohydramnios
  - Absent urinary bladder
  - Absent renal arteries (CDI)
  - Compression deformities secondary to extreme oligohydramnios

RENAL AGENESIS - BILATERAL



Arrows = empty renal fossae bilaterally

Note oligohydramnios

Renal Cystic Disease

- Spectrum of renal abnormalities characterized by replacement of normal renal parenchyma by nonfunctioning cystic tissue
- Potter classification:
  - Type I: infantile polycystic disease. (IPKD)
  - Type II: multicystic dysplastic kidney disease (MDKD)
  - Type III: adult polycystic kidney disease (APKD)
  - Type IV: obstructive cystic dysplasia

Infantile Polycystic Kidney Disease

- Replacement of renal parenchyma with microcystic disease tissue
- Kidneys bilaterally enlarged and sponge-like in texture
- Postnatal outcome varies based on renal function status

INFANTILE POLYCYSTIC KIDNEY DISEASE

Gross pathology

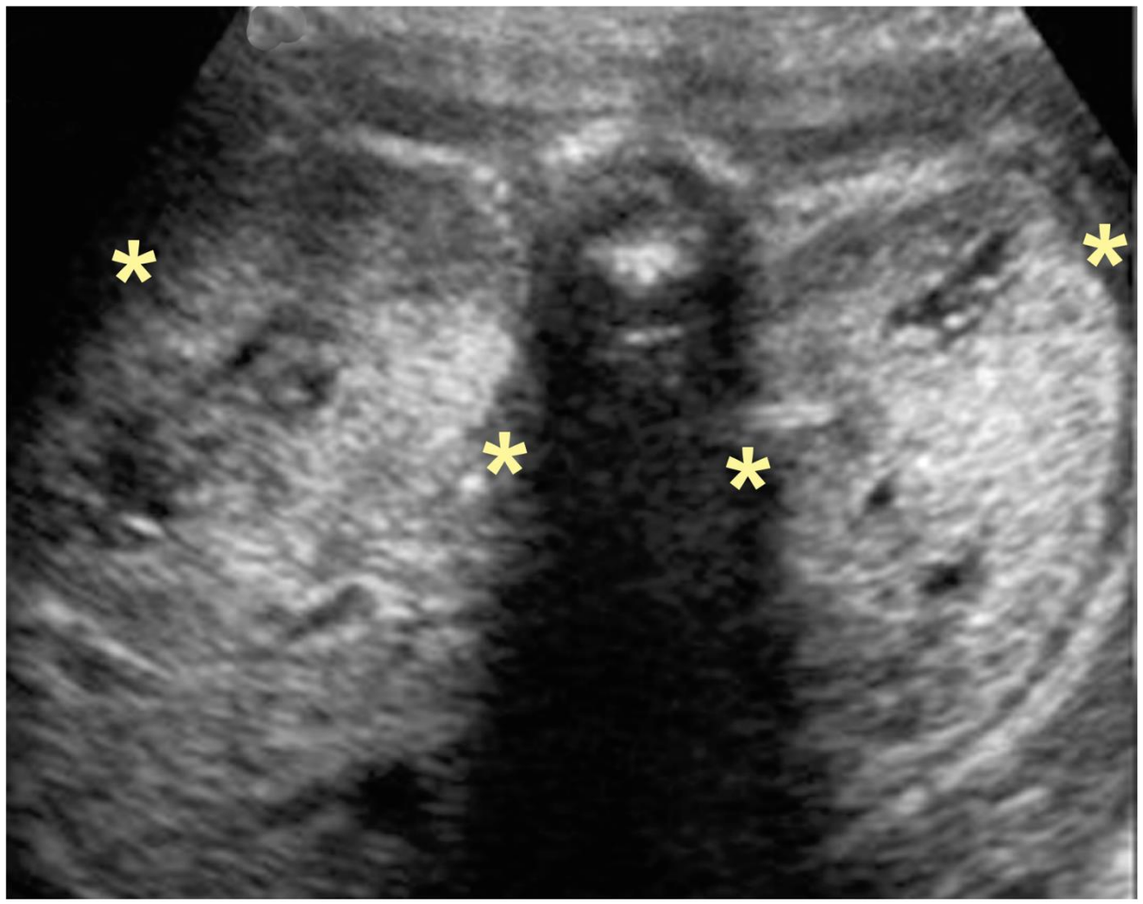
Infantile Polycystic Kidney Disease

- Associated abnormalities include :
  - Beckwith – Wiedemann syndrome
  - Meckel – Gruber syndrome
  - Trisomy 13 (Patau syndrome)
  - Other renal parenchymal diseases

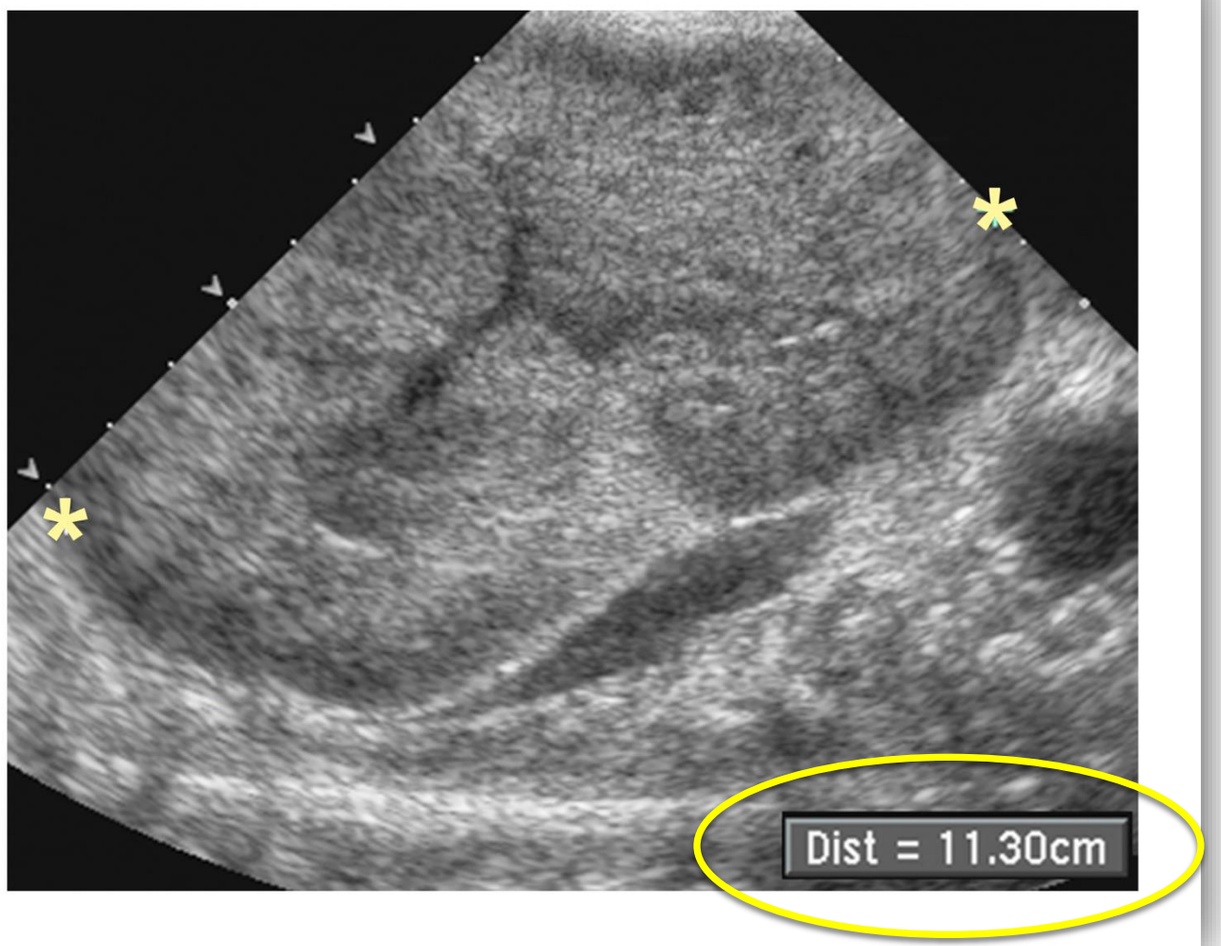
Infantile Polycystic Kidney Disease

- Sonographic findings vary with degree of disease but include :
  - Large, homogeneously hyperechoic kidneys bilaterally
  - Individual cysts cannot be differentiated (microcystic)
  - Increased kidney : AC ratio
  - Loss of corticomedullary differentiation
  - Kidneys may appear normal in early pregnancy (14 – 16 wks)
  - Presence or absence of urinary bladder
  - Oligohydramnios (when renal function is impaired)

INFANTILE POLYCYSTIC KIDNEY DISEASE



Prenatal findings



Postnatal findings

Multicystic Dysplastic Kidney Disease

- Congenital renal disorder characterized by cystic lesions corresponding to dilated collecting tubules
- Maybe segmental, unilateral, or bilateral
- Cysts vary in size, may reach up to 6 cm
- Postnatal outcome varies based on severity of disease and amount of functioning renal tissue present

MULTICYSTIC DYSPLASTIC KIDNEY DISEASE

Gross pathology

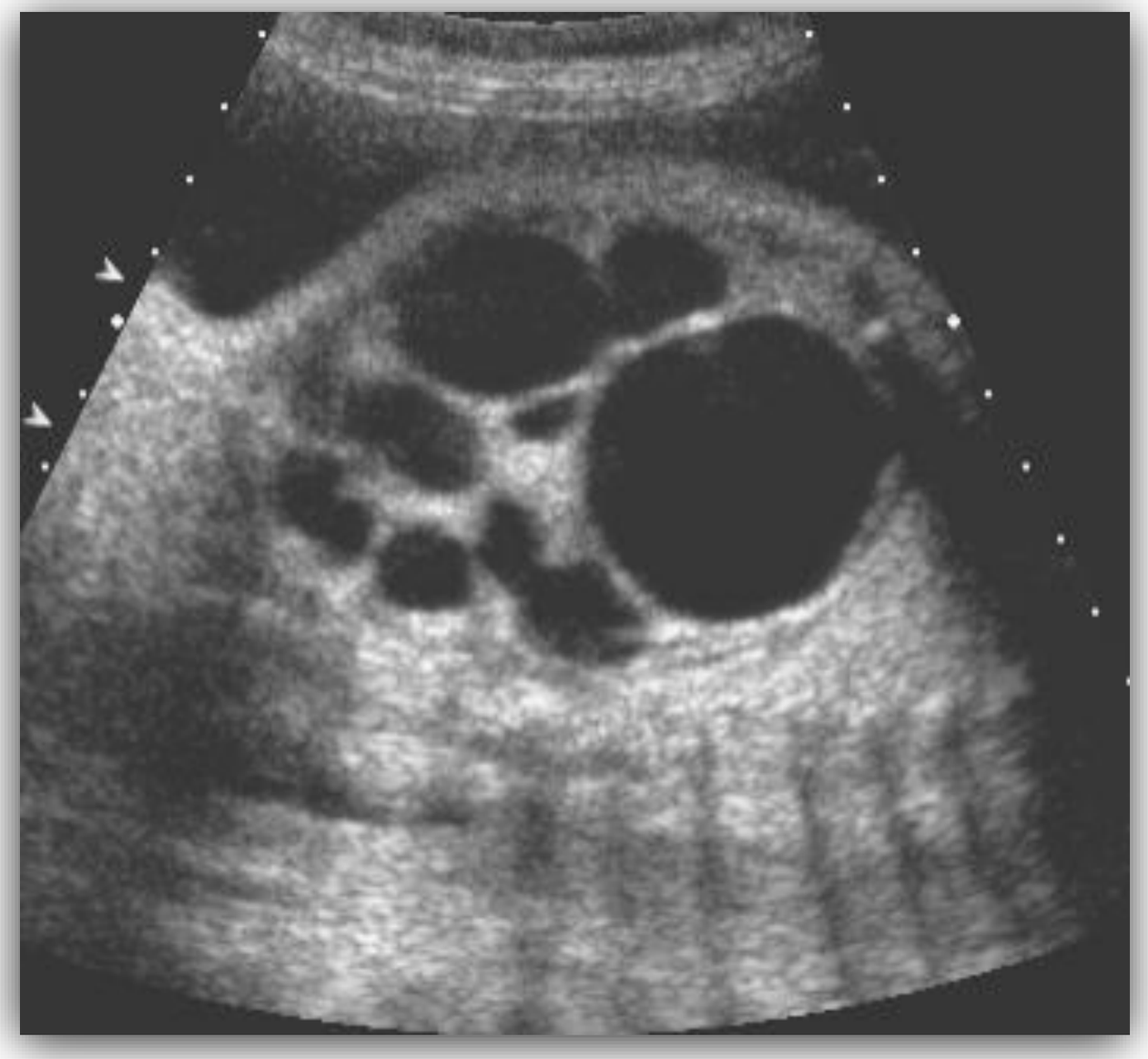
Multicystic Dysplastic Kidney Disease

- Associated abnormalities include :
  - Vesicoureteral reflux
  - Ureteropelvic junction obstruction
  - Ureterocele
  - Meckel – Gruber syndrome
  - Zellweger syndrome

Multicystic Dysplastic Kidney Disease

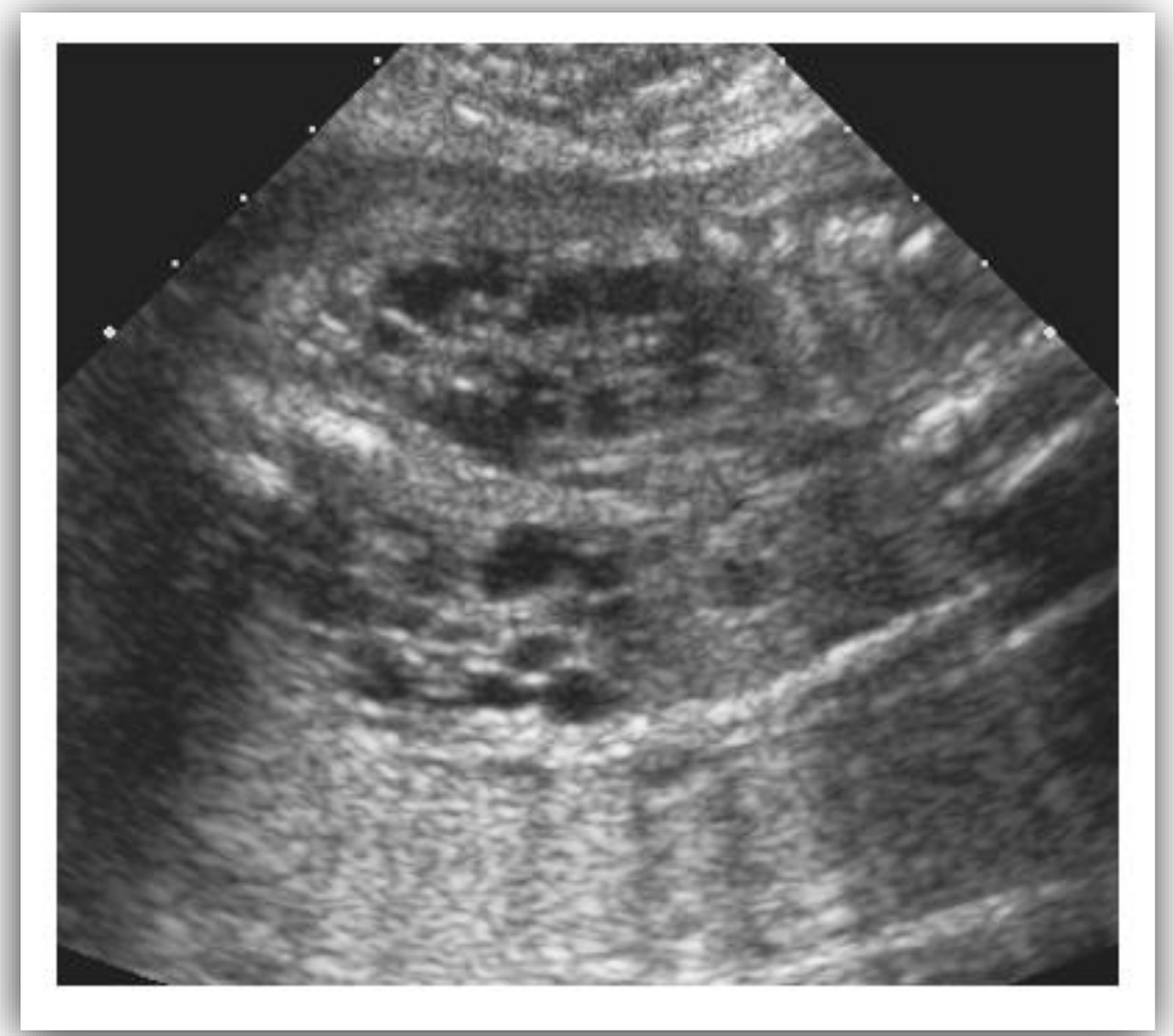
- Sonographic findings include :
  - Multiple, noncommunicating cysts in one or both kidneys
  - Lobulated renal contour
  - Echogenic renal parenchyma
  - Urimary bladder may. Be present or absent
  - Oligohydramnios when renal function is imparied

MULTICYSTIC DYSPLASTIC KIDNEY DISEASE



Multiple, noncommunicating cysts of varying size

MULTICYSTIC DYSPLASTIC KIDNEY DISEASE



Bilateral . Multiple renal cysts replacing normal renal parenchyma

Note oligohydramnios

Adult Polycystic Kidney Disease

- Rarely manifested prenatally
- Typically first appears in adults as etiology of unexpected end-stage renal disease (ESRD)
- By 30 years of age, ≈70% will demonstrate cysts on US
- About half progress to ESRD that requires dialysis or renal transplantation

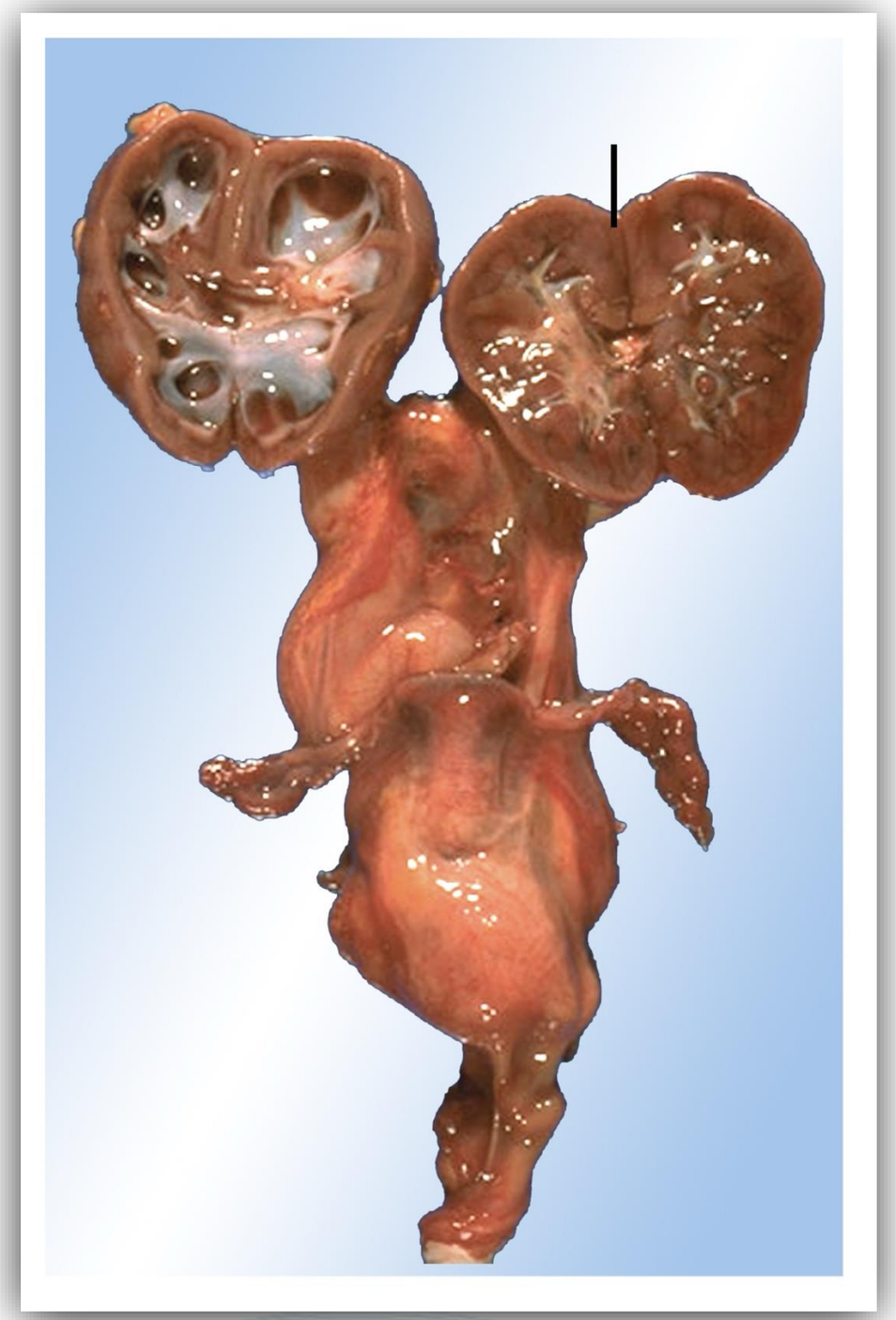
Adult Polycystic Kidney Disease

- Sonographic findings include :
  - Does not manifest prenatally
  - NONE

Obstructive Cystic Renal Dysplasia

- Characterized by appearance of dysplastic cysts in kidenys secondary to chronic outflow obstruction
- May be complete or segmental
- May be uni- or bilateral
- Outcomes dependent on amount of functioning renal tissue present

OBSTRUCTIVE CYSTIC RENAL DYSPLASIA



Gross pathology

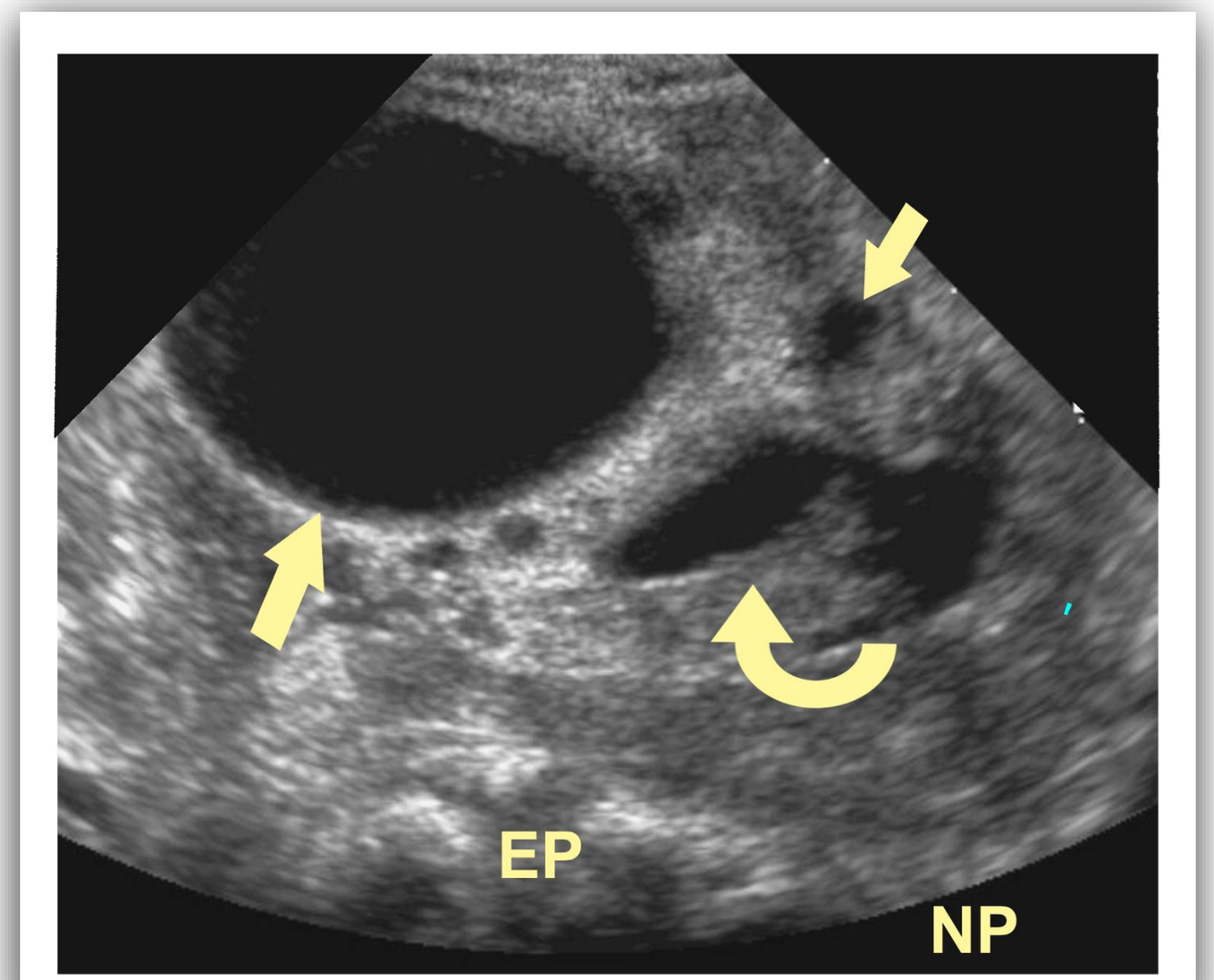
Obstructive Cystic Renal Dysplasia

- Associated abnormalities include :
  - Posterior urethral valves
  - Duplex collecting system
  - Ureteropelvic junction (UPJ) obstruction
  - VACTERL association
  - Congenital heart disease
  - CNS abnormalities
  - GI abnormalities

Obstructive Cystic Renal Dysplasia

- Sonographic findings include:
  - Scattered, noncommunicating cysts
  - Echogenic renal cortex
  - Evidence of obstructive uropathy on affected side as determined by level:
    - Dilated renal pelvis
    - Dilated collecting system
    - Dilated ureters
    - Bladder may or may not be dilated

OBSTRUCTIVE CYSTIC RENAL DYSPLASIA



Arrows = cystic dysplastic tissue
Curved arrow = obstructive uropathy

EP = echogenic parenchyma
NP = normal parenchyma

Obstructive Uropathies

- Generic term for any congenital or acquired process that obstructs the outflow of the urinary tract
- Obstruction may be uni- or bilateral, temporary or permanent
- May occur at any level along the excretory system
- Categories based on level of obstruction

Obstructive Uropathies

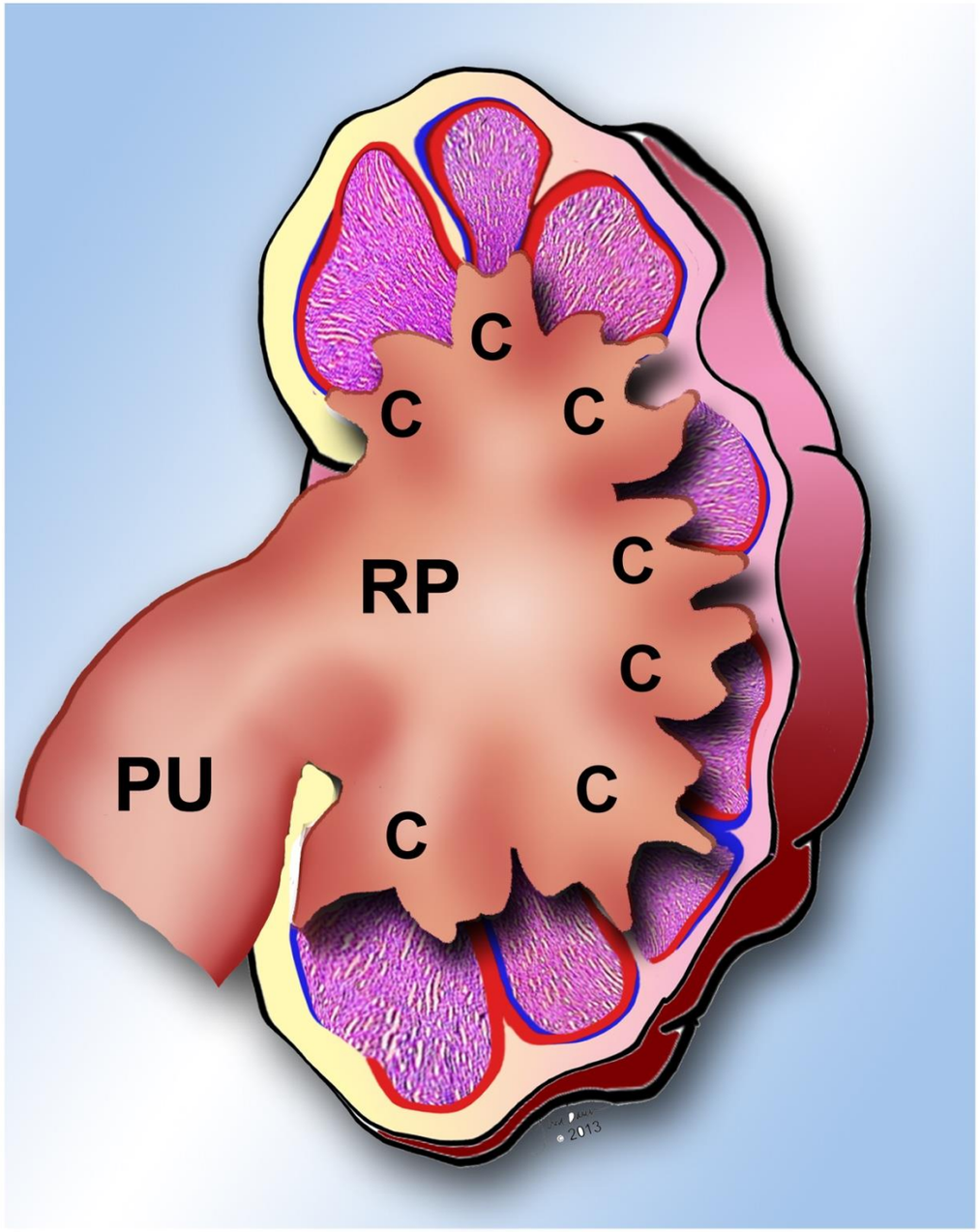
- Kidney
  - Hydronephrosis
- Ureters
  - Ureteropelvic junction (UPJ) obstruction
  - Ectopic ureterocele
  - Congenital primary megaureter
  - Duplicated collecting system
- Bladder

Obstructive Uropathies

- Kidney
- Ureters
- Bladder
  - Bladder outlet obstruction
  - Posterior urethral valves
  - Urethral atresia/stenosis
  - Prune belly syndrome

GU ABNORMALITIES – HYDRONEPHROSIS

PU = proximal ureter
RP = renal pelvis
C = dilated calyces



Hydronephrosis

- Dilatation of the renal collecting system
- Differentiated by normal *fetal pyelectasis*

Rule of Thumb

Hydronephrosis is present when APD measures:

> 5 mm before 20 weeks

> 8 mm after 20 weeks

FETAL GENITOURINARY SYSTEM

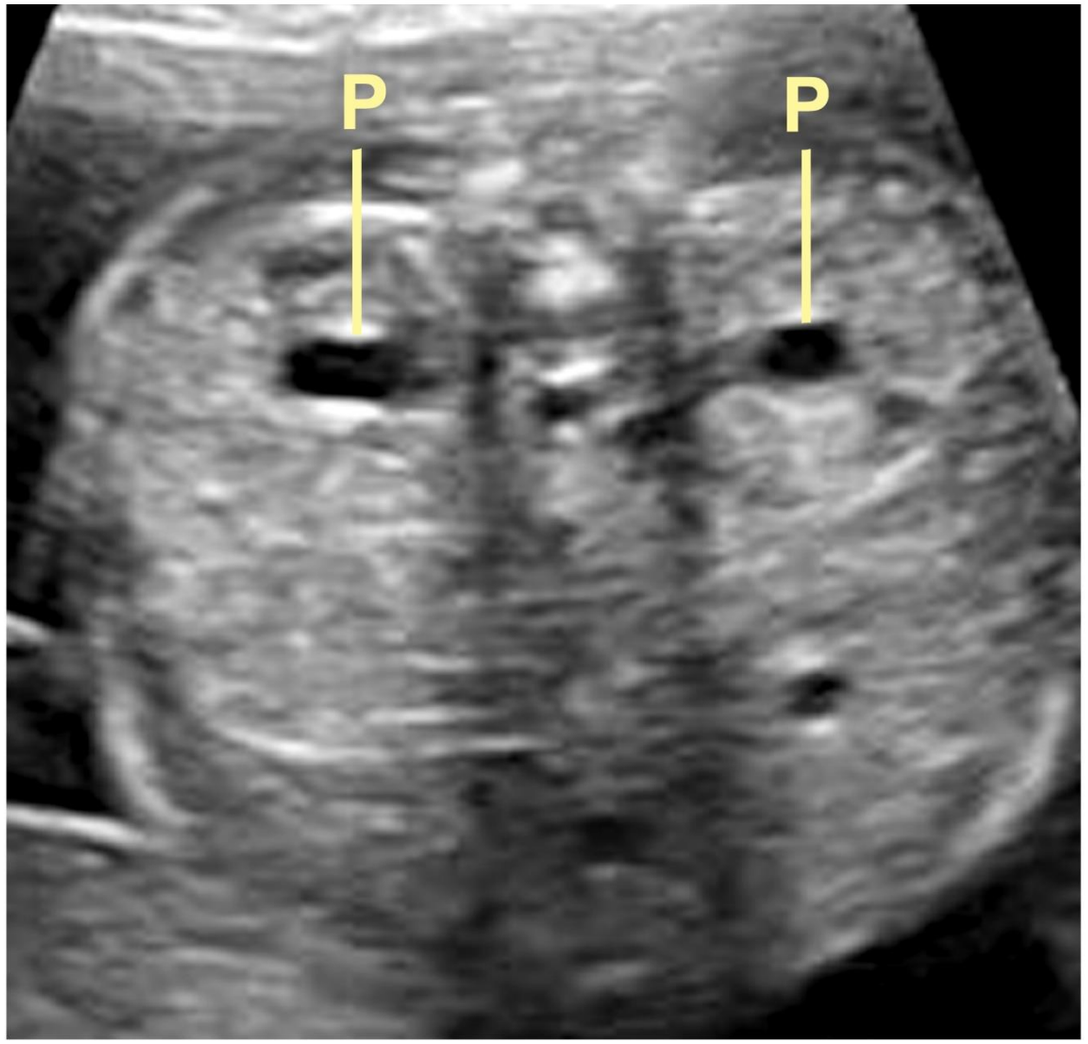
AP RENAL PELVIS MEASUREMENTS	
< / = 5mm	Normal
5 – 10mm	Probably normal, follow up
> / = 10mm	85% have anatomic anomaly

AGE RELATED RENAL PELVIS MEASUREMENTS	
Weeks	AP measurement (mm)
13 – 20	5
20 – 30	8
>30	10

Hydronephrosis

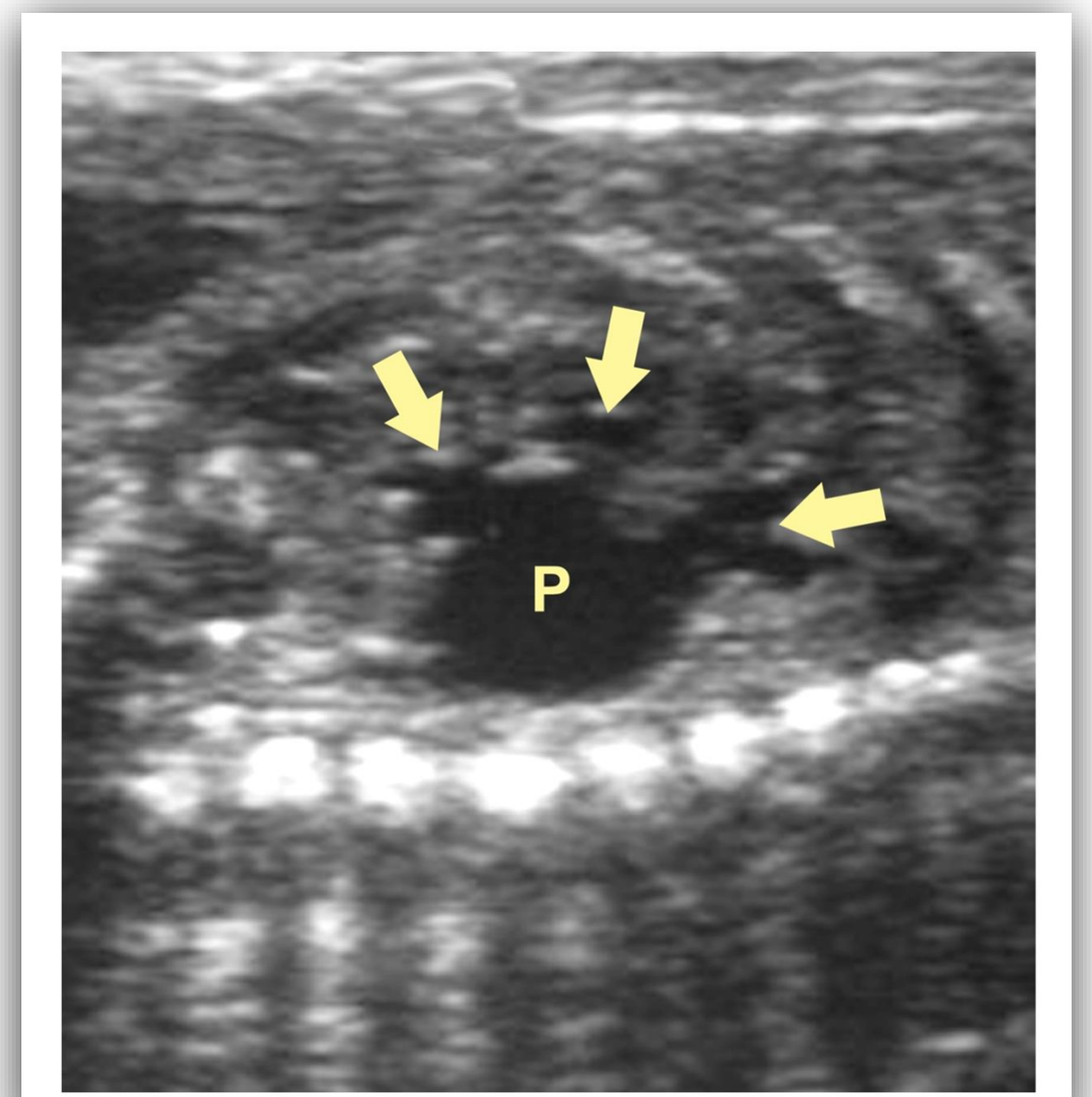
- Sonographic findings include:
  - Cystic dilatation of renal pelvis > than values given above
  - Communication with dilated calyces (caliectasis)
  - Possible presence of dilated proximal ureter
  - Thinning of renal cortex

GU ABNORMALITIES – HYDRONEPHROSIS



P = bilateral dilated renal pelvises

GU ABNORMALITIES – HYDRONEPHROSIS



P = bilateral dilated renal pelvis
Arrows = dilated calyces

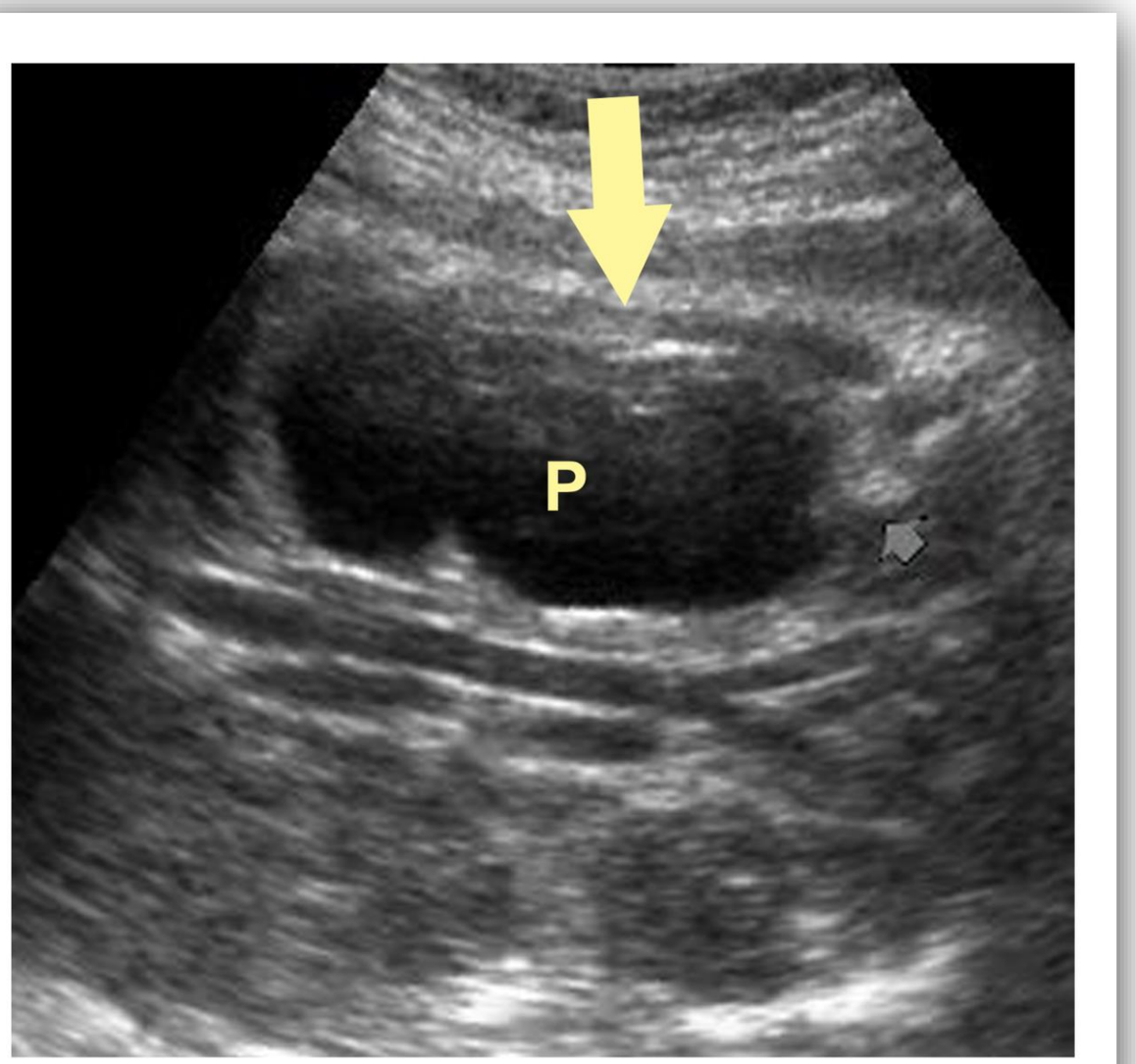
Ureteropelvic Junction Obstruction

- Results from incomplete canalization of renal pelvis and proximal ureter in embryo
- External compression by fibrous bands or aberrant blood vessels may also obstruct flow
- Flow restriction causes backup behind the obstruction
- Relatively common
- Typically unilateral

Ureteropelvic Junction Obstruction

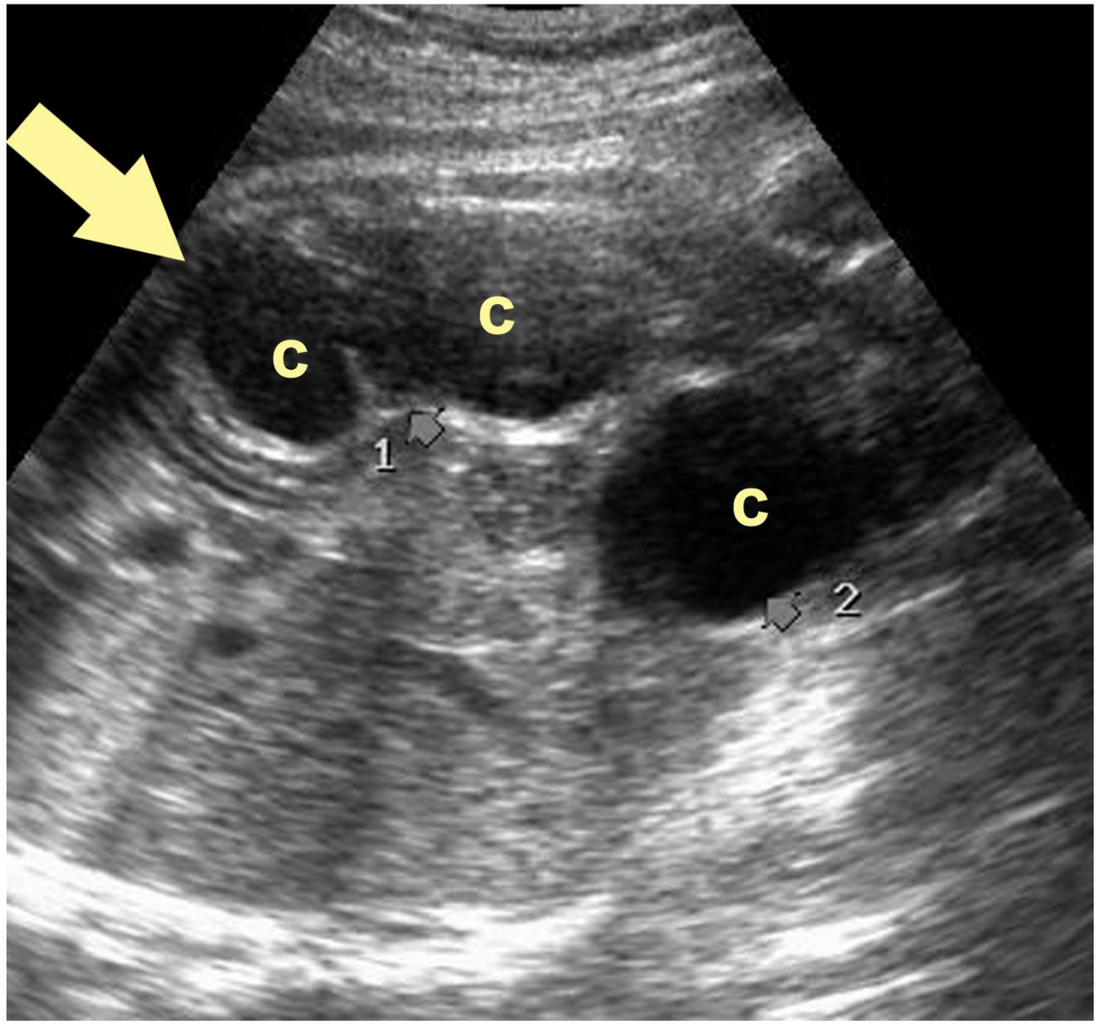
- Sonographic findings include:
  - Cystic dilatation of renal pelvis
  - Communication with dilated calyces (caliectasis)
  - Enlarged kidney
  - Thinning of renal cortex

GU ABNORMALITIES – UPJ OBSTRUCTION



P = bilateral dilated renal pelvis
Arrow = thinned renal cortex

GU ABNORMALITIES – UPJ OBSTRUCTION

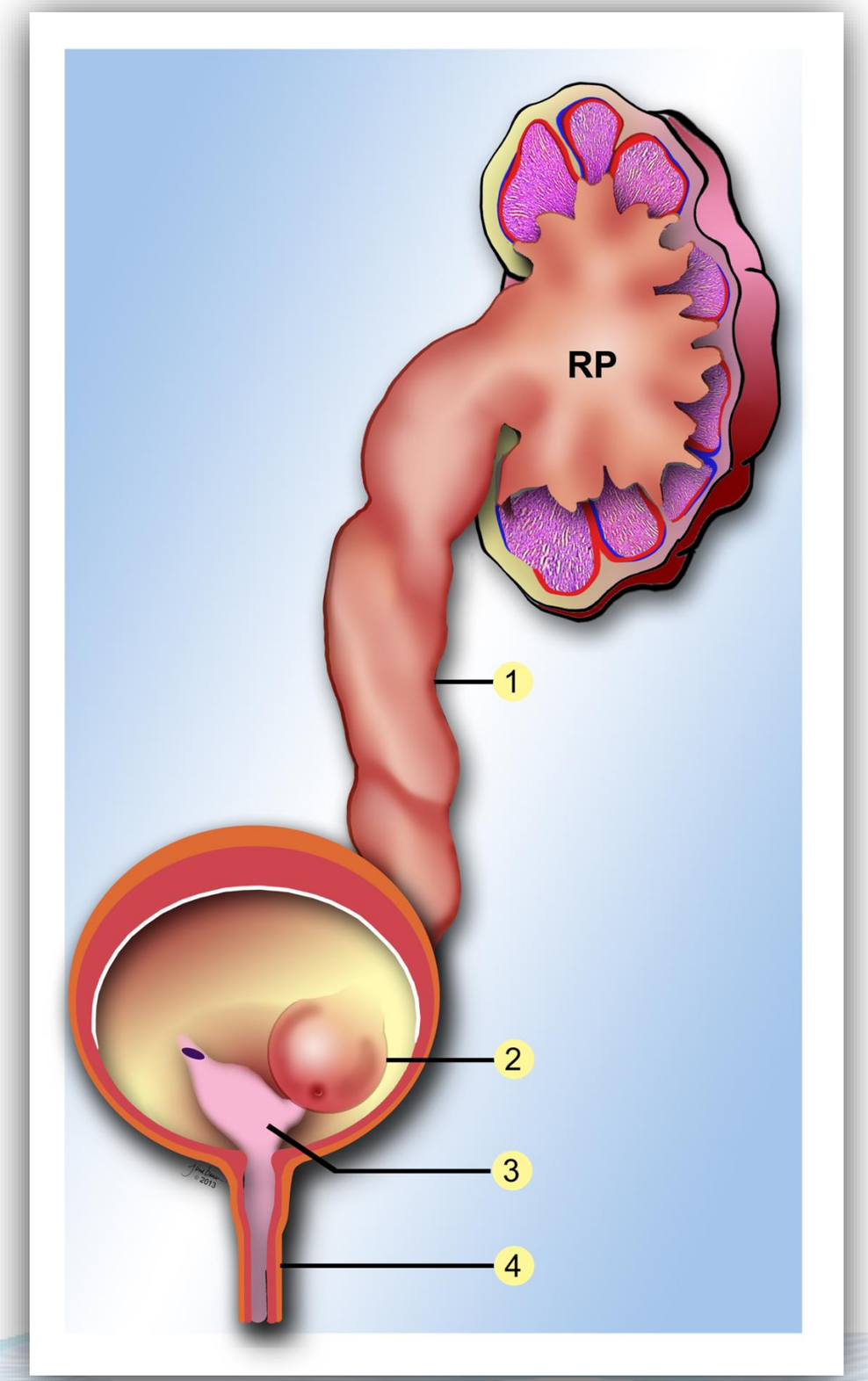


C = caliectasis
Arrows = thinned renal cortex

Ectopic Ureterocele

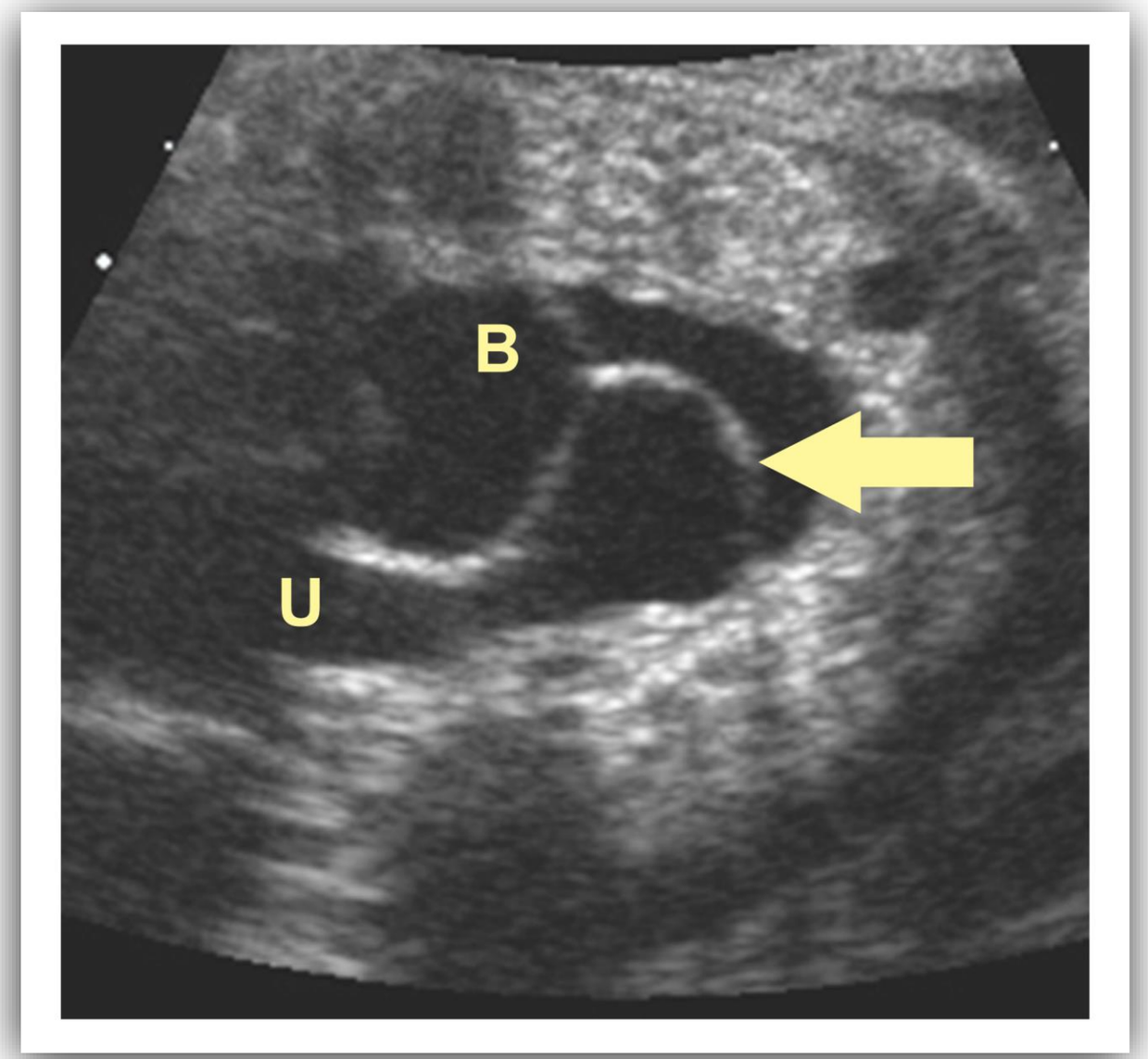
- Results from abnormal location of ureteral insertion into the bladder *OR*…..
- Distal ureter herniates into bladder producing progressive and self-obstructing dilatation of the ureter
- Both result in chronic obstruction and progressive dilation of collecting system upstream

GU ABNORMALITIES – ECTOPIC URETEROCELE



RP = renal pelvis
1 = hydroureter
2 = ureterocele
3 = trigone
4 = urethra

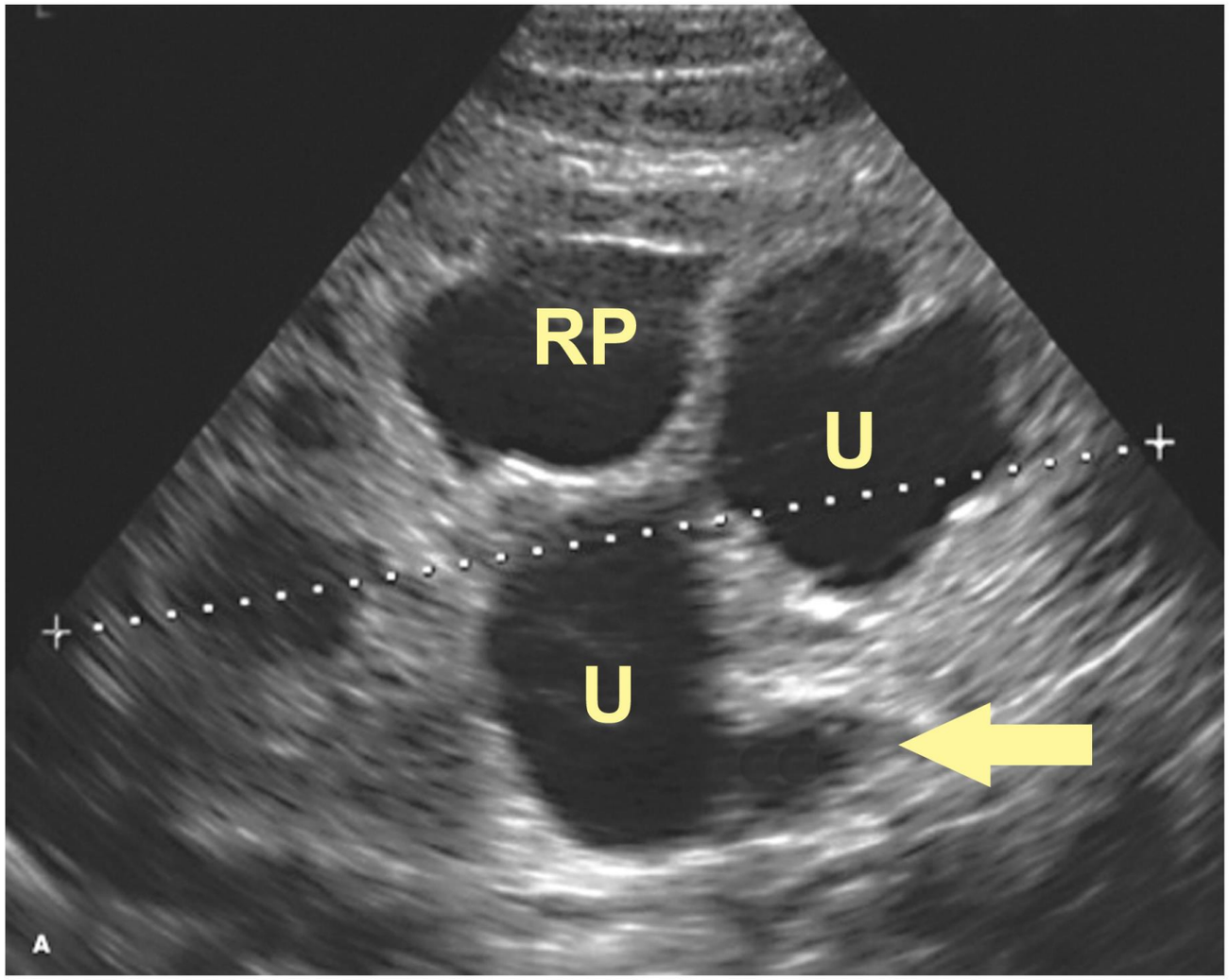
GU ABNORMALITIES – ECTOPIC URETEROCELE



Arrow = ureterocele

U = dilated ureter
B = urinary bladder

GU ABNORMALITIES – ECTOPIC URETEROCELE



Arrow = distal ureter

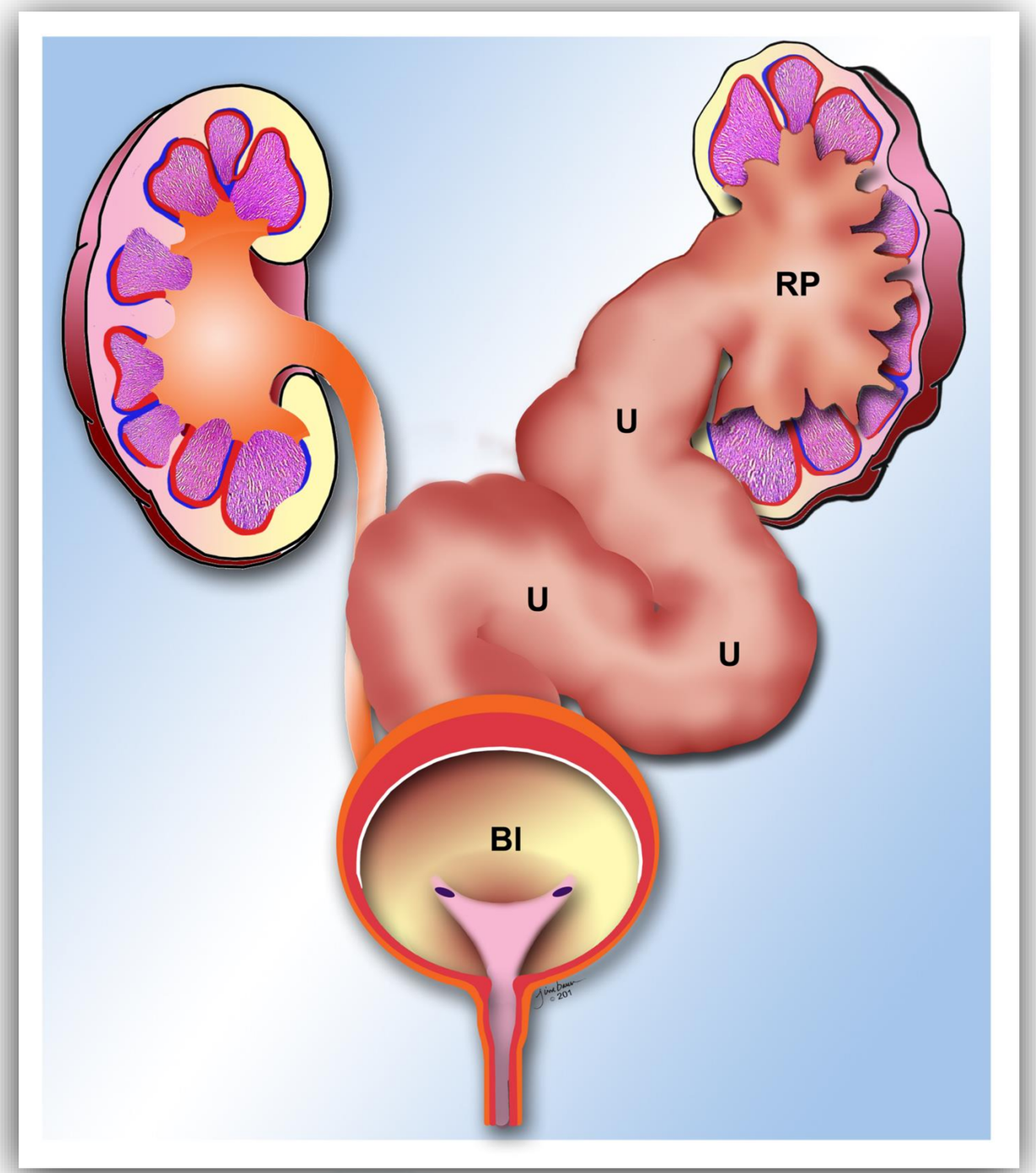
RP = renal pelvis
U = dilated, tortuous ureter

Congenital Primary Megaureter

- Chronic dilatation of the ureter related to abnormalities of the ureter, *per se*, rather than distal obstructive pathology
- May or may not be associated with dilated renal pelvis and calyces
- Etiologies include:
  - Ureterovesical junction reflux
  - Ureter insertion site abnormalities
  - Physiological obstruction (adynamic distal ureter)

GU ABNORMALITIES – CONGENITAL PRIMARY MEGAURETER

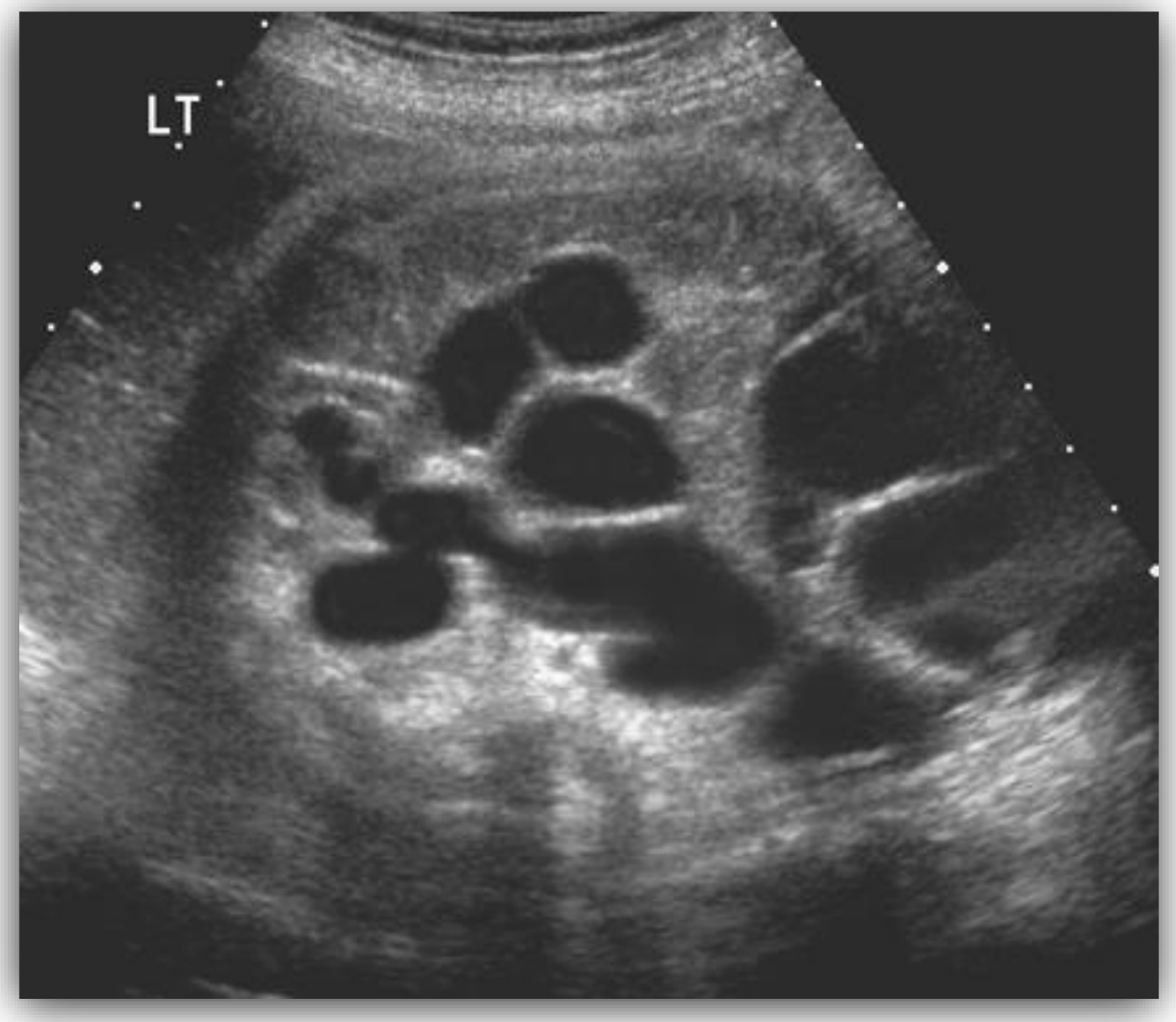
RP = renal pelvis
U = ureter
Bl = urinary bladder



Congenital Primary Megaureter

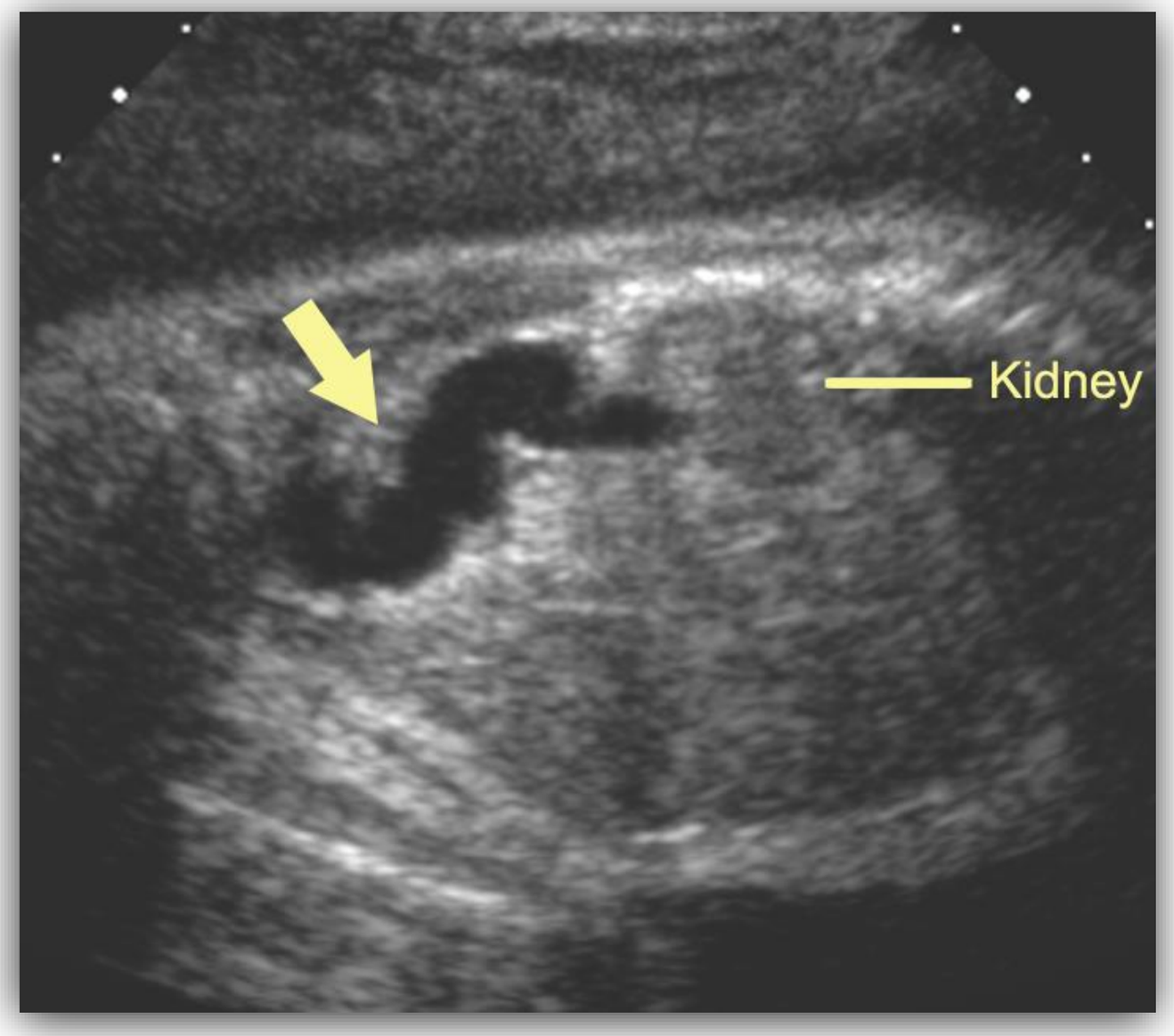
- Sonographic findings include:
  - Large, tortuous ureter filling the fetal abdomen
  - Tapering of dilated distal ureter
  - Normal bladder filling and emptying

GU ABNORMALITIES – CONGENITAL PRIMARY MEGAURETER



Dilated , tortuous ureter filling fetal abdomen

GU ABNORMALITIES – CONGENITAL PRIMARY MEGAURETER



Arrow = dilated ureter

Duplicated Collecting System

- Duplication of renal collecting system resulting from incomplete fusion of upper and lower pole segmens in embryo
- May be uni- or bilateral
- Upper pole collecting system often dilated by obstruction of upper pole ureter
- Lower pole segment is usually not affected

Duplicated Collecting System

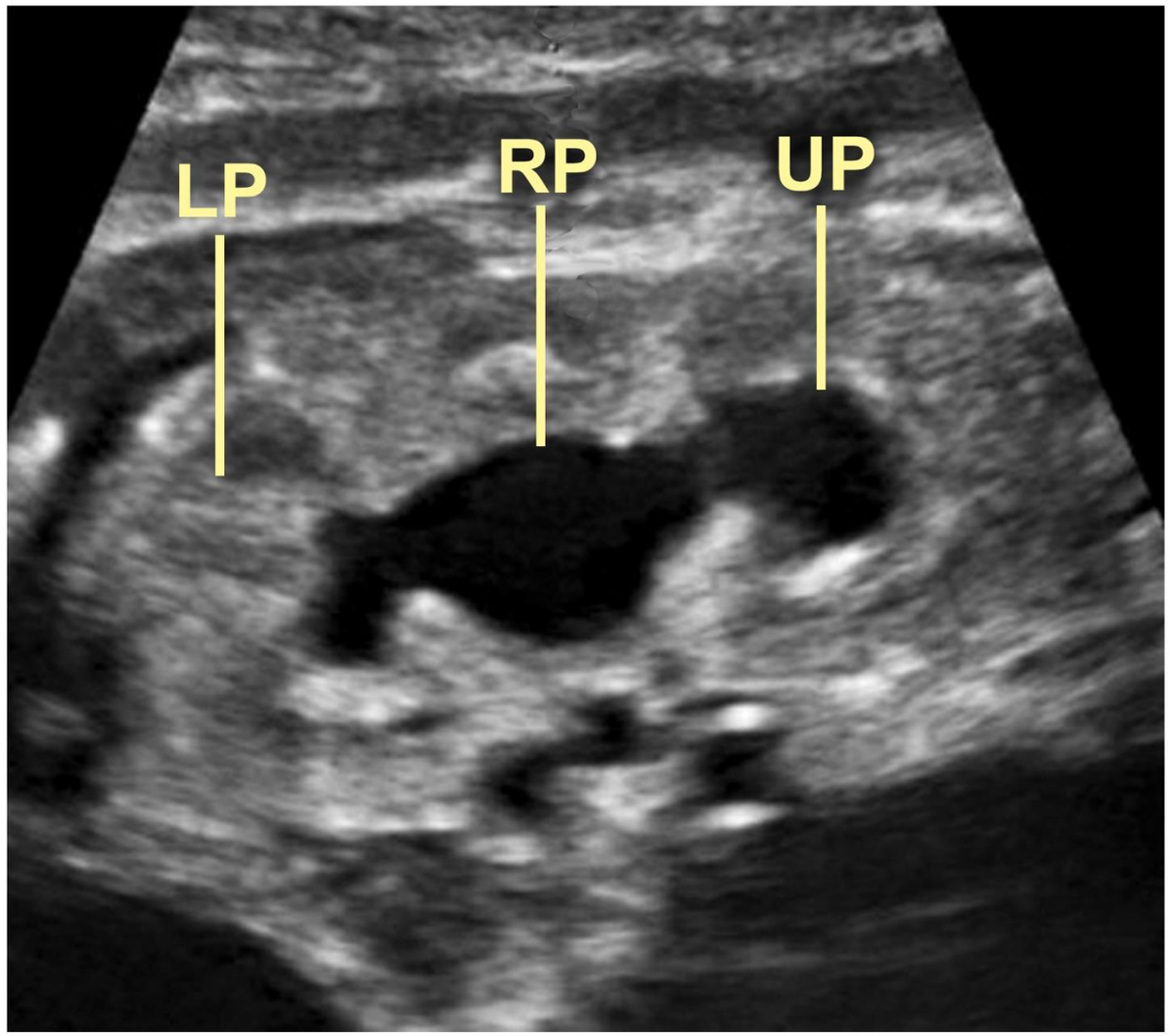
- Associated abnormalities include:
  - Ectopic ureterocele
  - Vesicoureteral reflux
  - Hydronephrosis

Duplicated Collecting System

- Sonographic findings include:
  - Cystic dilation of upper pole collecting system
  - Ipsilateral ureteral dilatation down to the bladder
  - Presence of ureterocele (common)
  - Nondilated lower pole collecting system

GU ABNORMALITIES – DUPLICATED COLLECTING SYSTEM

LP = lower pole
RP = renal pelvis
UP = upper pole



Dilated upper pole collecting system
Normal lower pole

Bladder Outlet Obstruction

- Generic term for blockage of urinary tract at the urethral level

- Most common cause in male fetuses: *posterior urethral valves*

- Most common cause in female fetuses: *urethral atresia*

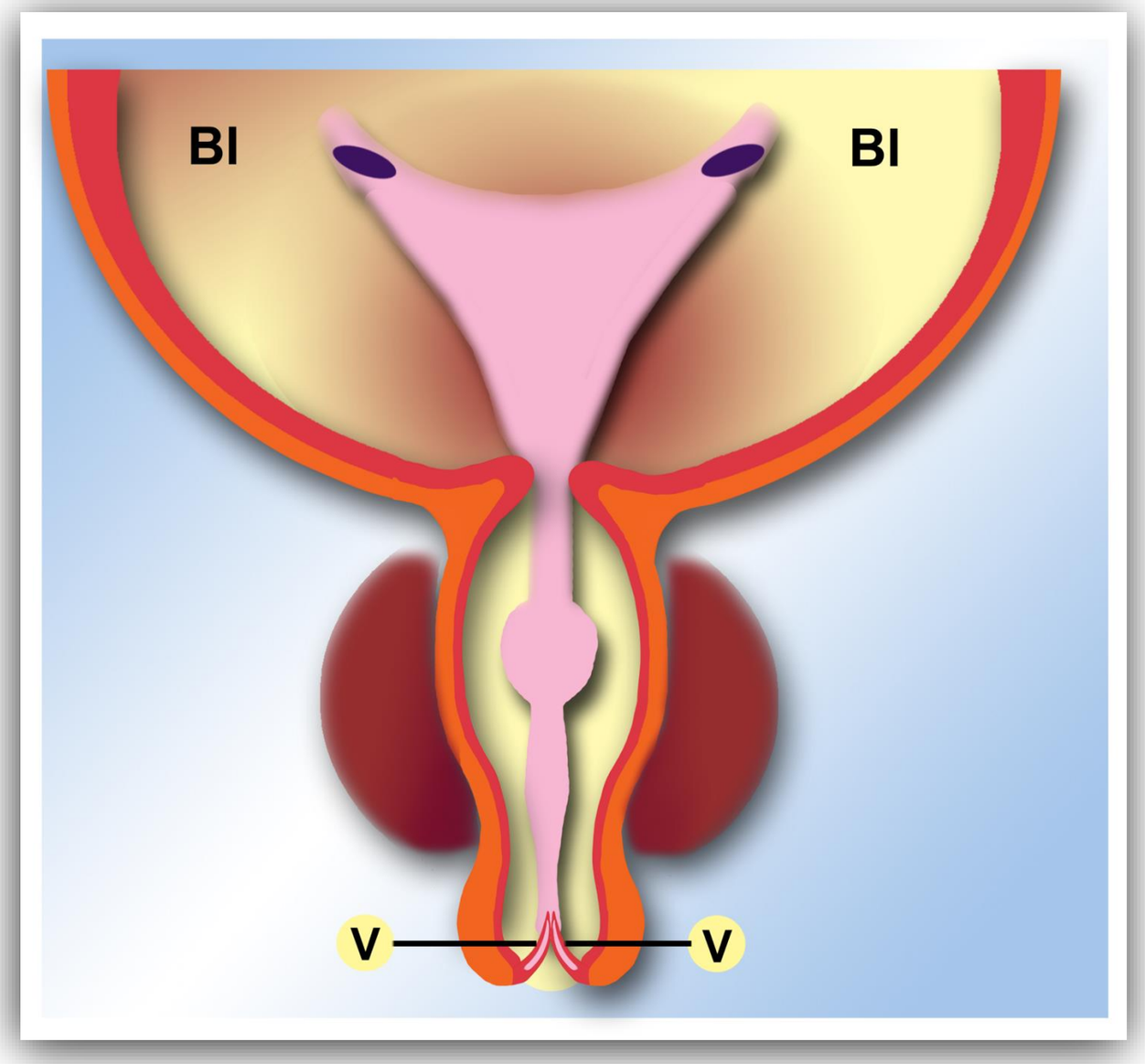
- Sonographic findings in all cases are similar and specific etiology cannot usually be determined prenatally

Posterior Urethral Valves

- Congenital folds in urethra act as valves obstructing outflow of urine into amniotic cavity

GU ABNORMALITIES – POSTERIOR URETHRAL VALVES

V = urethral valves
Bl = urinary bladder



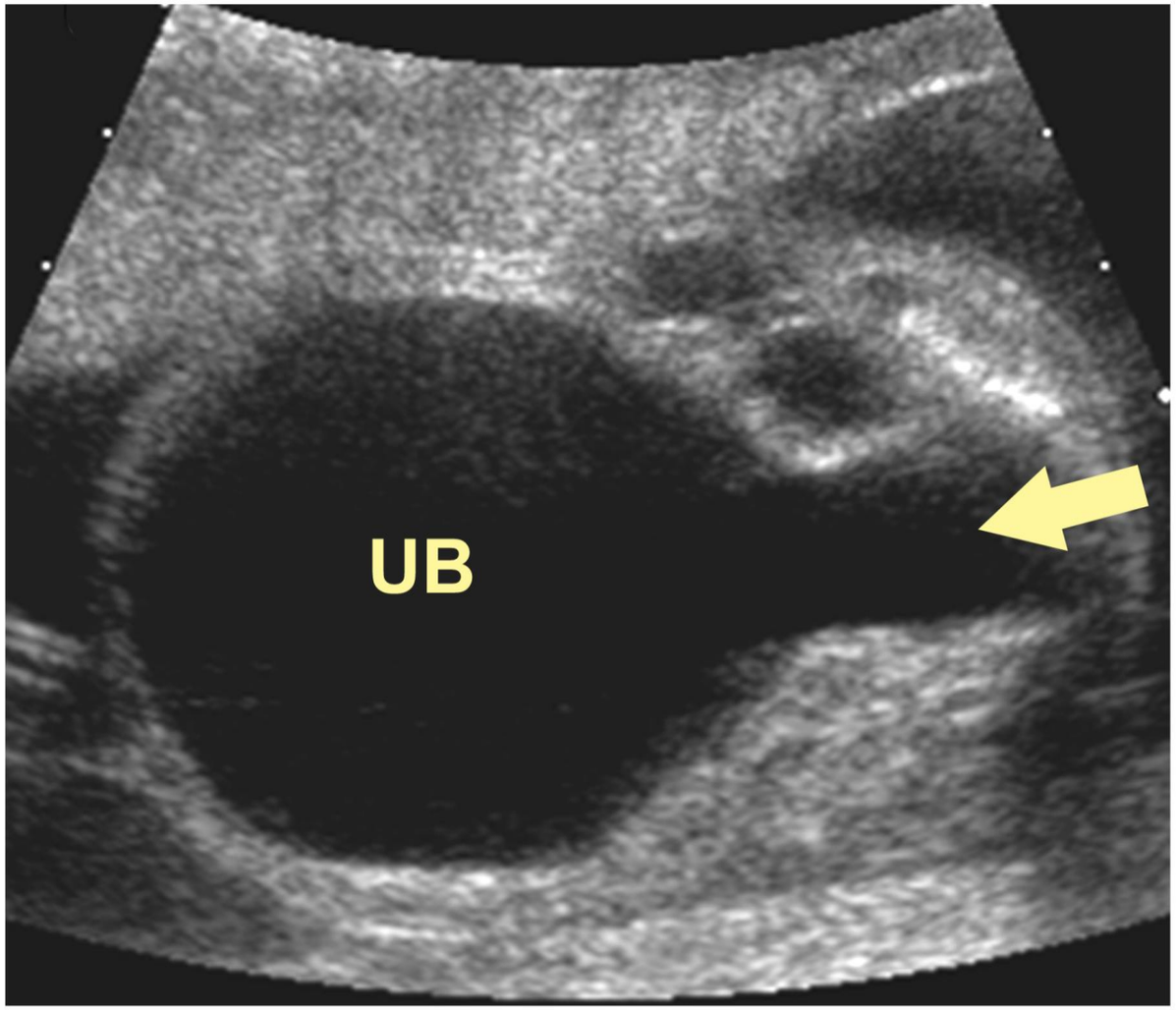
Urethral Atresia/Stenosis

- Congenital absence of urethra
- May be associated with congenital absence of bladder

Bladder Outlet Obstruction

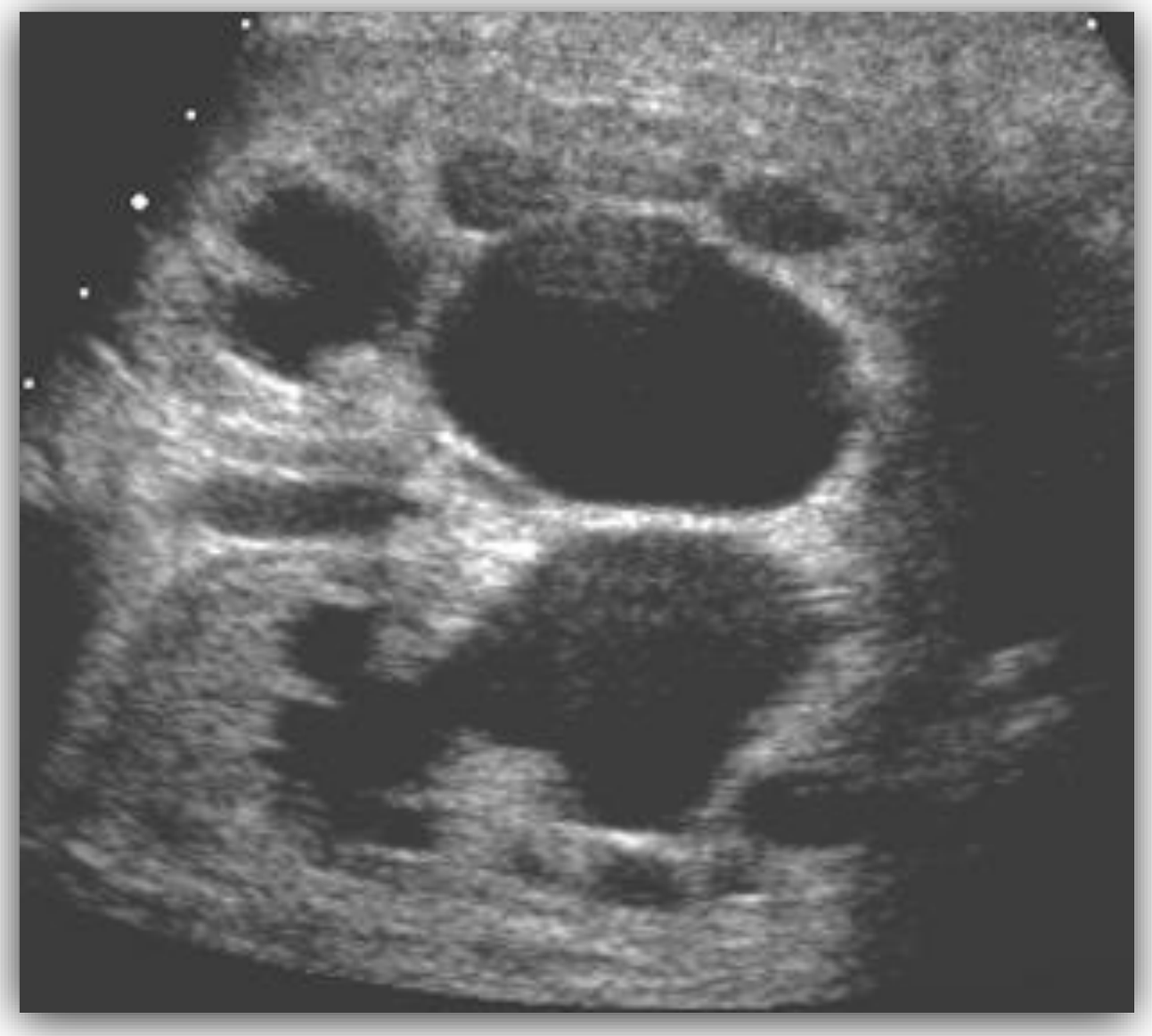
- Sonographic findings include:
  - Cystic dilation of upper pole collecting system
  - Ipsilateral ureteral dilatation down to the bladder
  - Presence of ureterocele (common)
  - Nondilated lower pole collecting system

GU ABNORMALITIES – BLADDER OUTLET OBSTRUCTION



UB = urinary bladder
Arrow = dilate proximal urethra

GU ABNORMALITIES – BLADDER OUTLET OBSTRUCTION



Bilateral urinary tract dilatation

Prune Belly Syndrome

- Also known as Eagle-Barrett syndrome
- Triad syndrome consisting of:
  - Anterior abdominal wall distention and atrophy
  - Urinary tract obstruction
  - Undescended tested (cryptorchidism)
- 95% in male fetuses
- Severe oligohydramnios results in pulmonary hypoplasia that contributes to postnatal morbidity and mortality

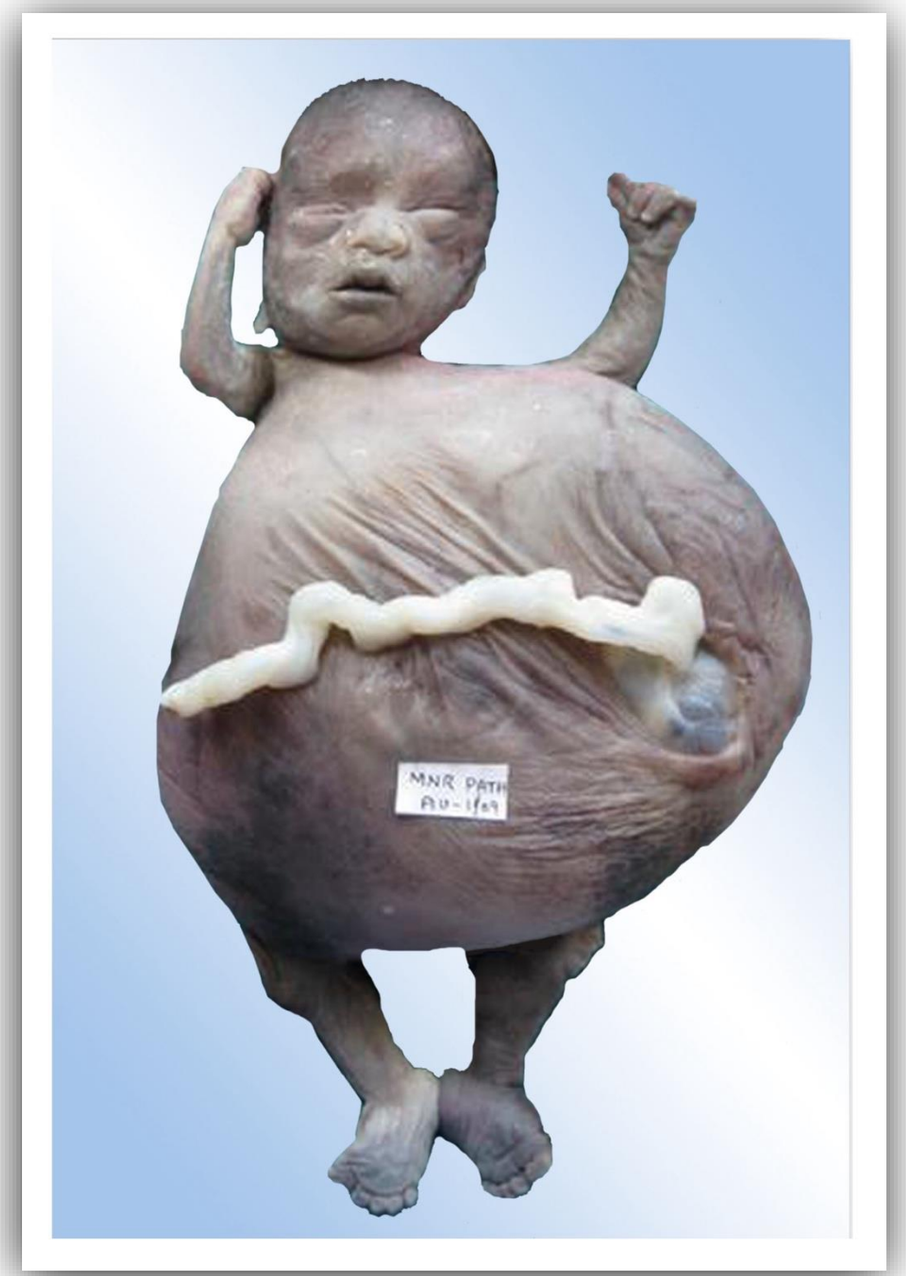
Prune Belly Syndrome

- Associated abnormalities include:
  - Pulmonary hypoplasia
  - Trisomies 13 (Patau syndrome) and 18 (Edwards syndrome)
  - Congenital cardiac anomalies
  - Imperforate anus
  - Polydactyly/syndactyly
  - Clubfoot (talipes equinovarus)

Prune Belly Syndrome

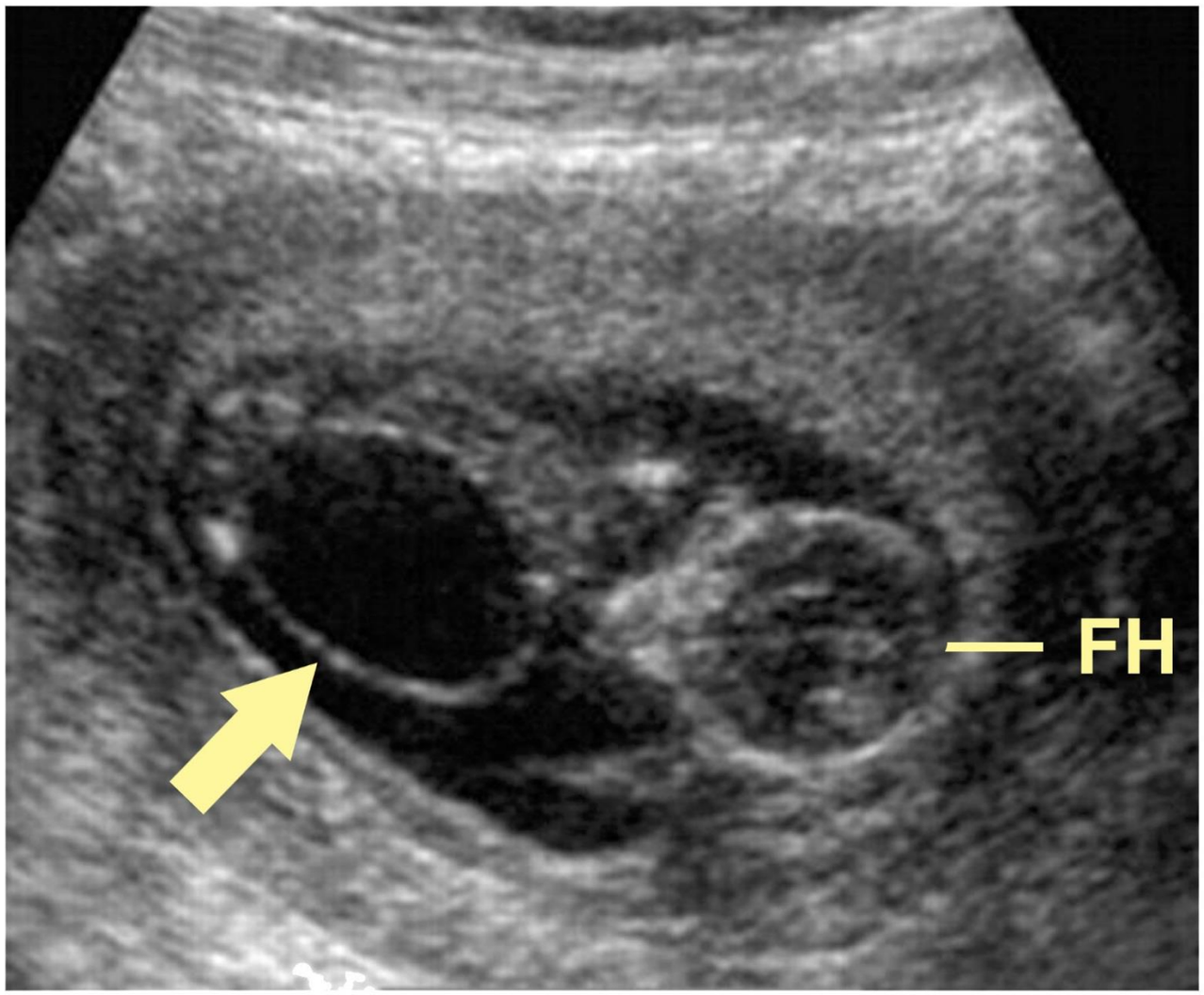
- Sonographic findings include:
  - Hyperechoic renal parenchyma
  - Clubbed, dilated calyces
  - Dilated, tortuous ureters
  - Large, megacystic bladder

GU ABNORMALITIES – PRUNE BELLY SYNDROME



Gross pathology

GU ABNORMALITIES – PRUNE BELLY SYNDROME



FH = fetal head
Arrow = megacystis

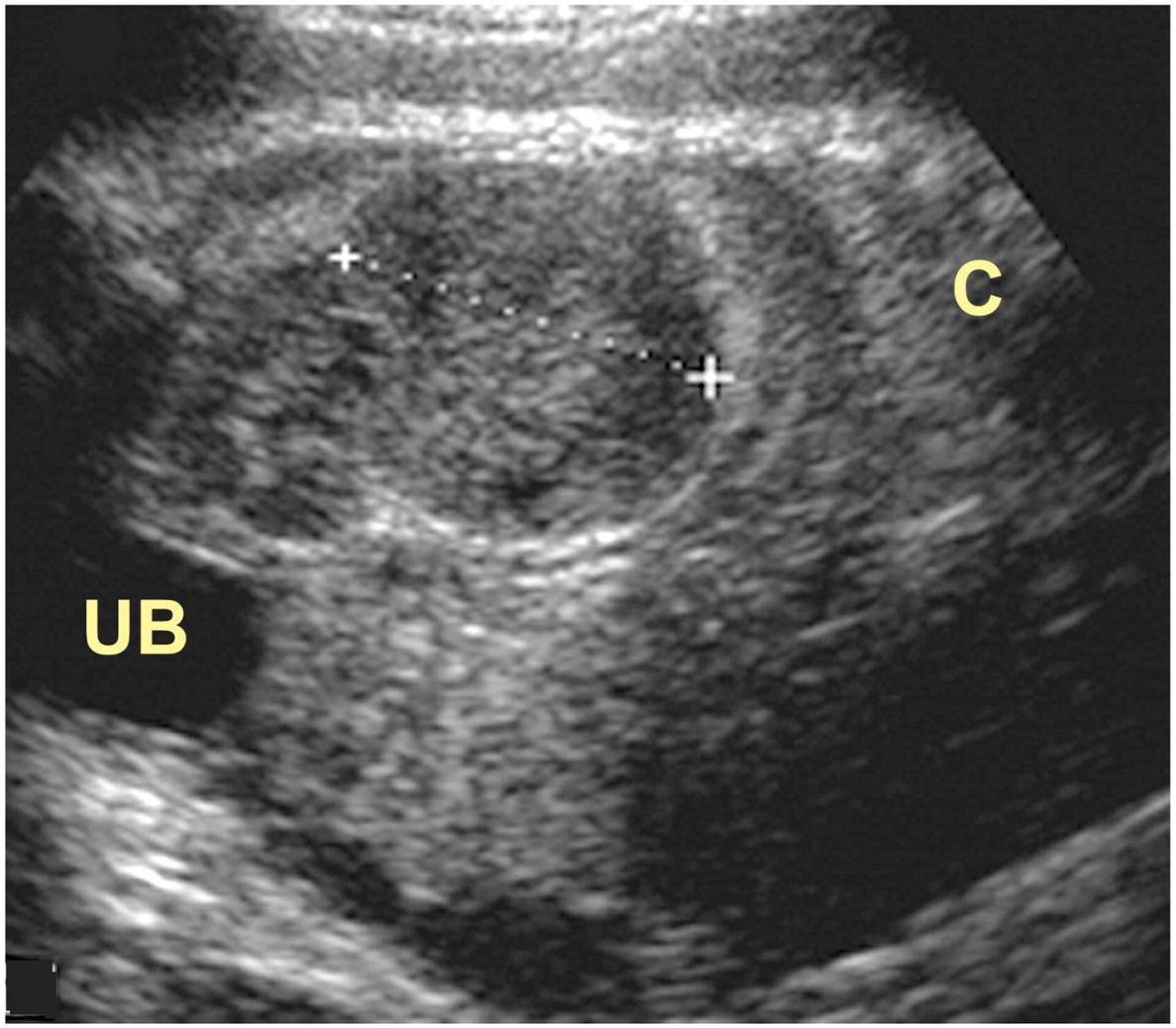
Genitourinary Neoplasms

- Several types of solid renal and adrenal masses may occur *in utero*. They include:
  - Congenital adrenal neuroblastoma
  - Wilms tumor (nephroblastoma)
  - Congenital mesoblastic nephroma
- All are solid masses with robust hemodynamic characteristics
- Cannot differentiate tissue type prenatally

Genitourinary Neoplasms

- Sonographic findings include:
  - Solid mass in the renal fossa
  - Complex mass, may contain septations
  - Distortion of adjacent anatomic architecture
  - Color Doppler may show:
    - Feeding vessel into mass
    - Diffuse vascularity throughout mass

GU ABNORMALITIES – GENITOURINARY NEOPLASMS

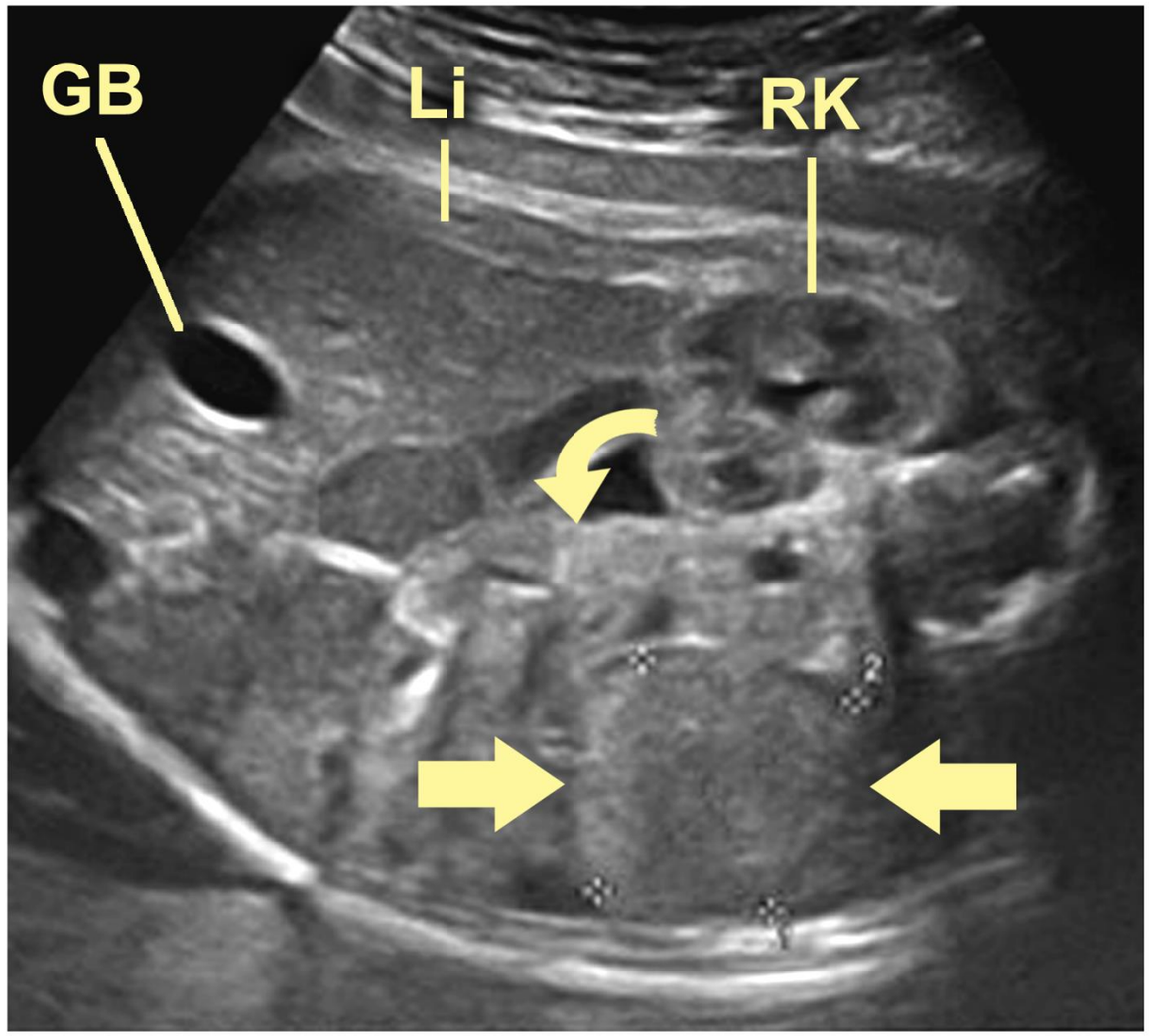


UB = urinary bladder
C = chest

GU ABNORMALITIES – GENITOURINARY NEOPLASMS

GB = gall bladder
Li = liver
Arrows = mass

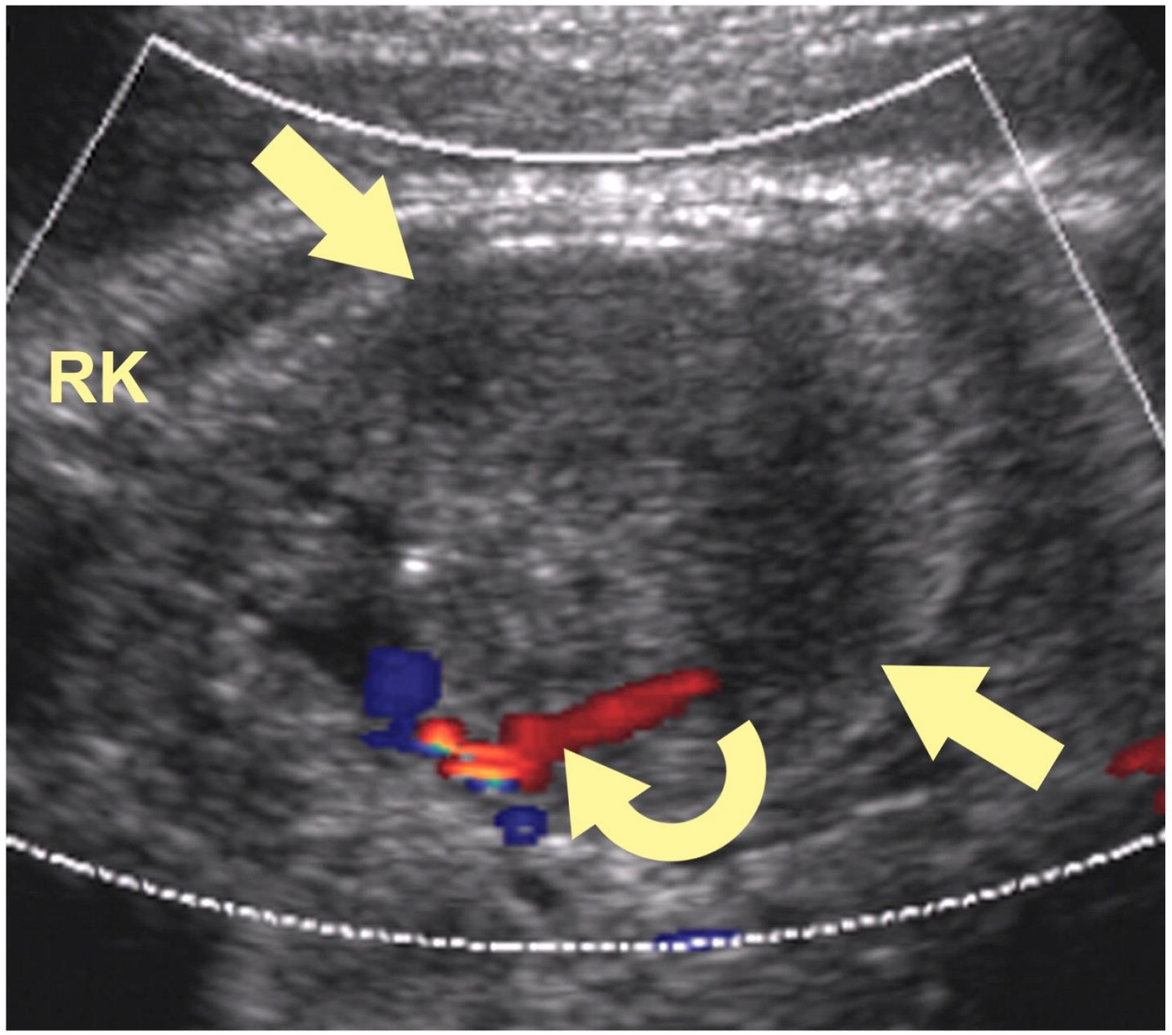
Curved = displaced retroperitoneal anatomy



Distortion of adjacent anatomic architecture

GU ABNORMALITIES – GENITOURINARY NEOPLASMS

RK = right kidney
Arrows = mass



Color Doppler showing feeding artery (Curved arrow)

OB GYN SONOGRAPHY REVIEW

Fetal Genitourinary System