

Fetal

Abdomen

Chapter 63

Embryology of the Digestive System

◉ **Primitive gut**

- **Forms during the fourth week**
 - **Dorsal part of the yolk sac is incorporated into the embryo during folding**
- **Divided into three sections**
 - **Foregut**
 - **Midgut**
 - **Hindgut**

Foregut

- ◉ **Pharynx**
- ◉ **Lower respiratory system**
- ◉ **Esophagus**
- ◉ **Stomach**
- ◉ **Part of the duodenum**
- ◉ **Liver**
- ◉ **Biliary**
- ◉ **Pancreas**

Midgut

- **Small intestines**
 - **Including most of the duodenum**
- **Cecum**
- **Variform appendix**
- **Ascending colon**
- **Most of the transverse colon**

- **All of these structures are supplied by the SMA**

Hindgut

- ◉ **Left part of the transverse colon**
- ◉ **descending colon**
- ◉ **sigmoid colon**
- ◉ **Rectum**
- ◉ **superior portion of the anal canal**
- ◉ **epithelium of the urinary bladder**
- ◉ **most of the urethra**

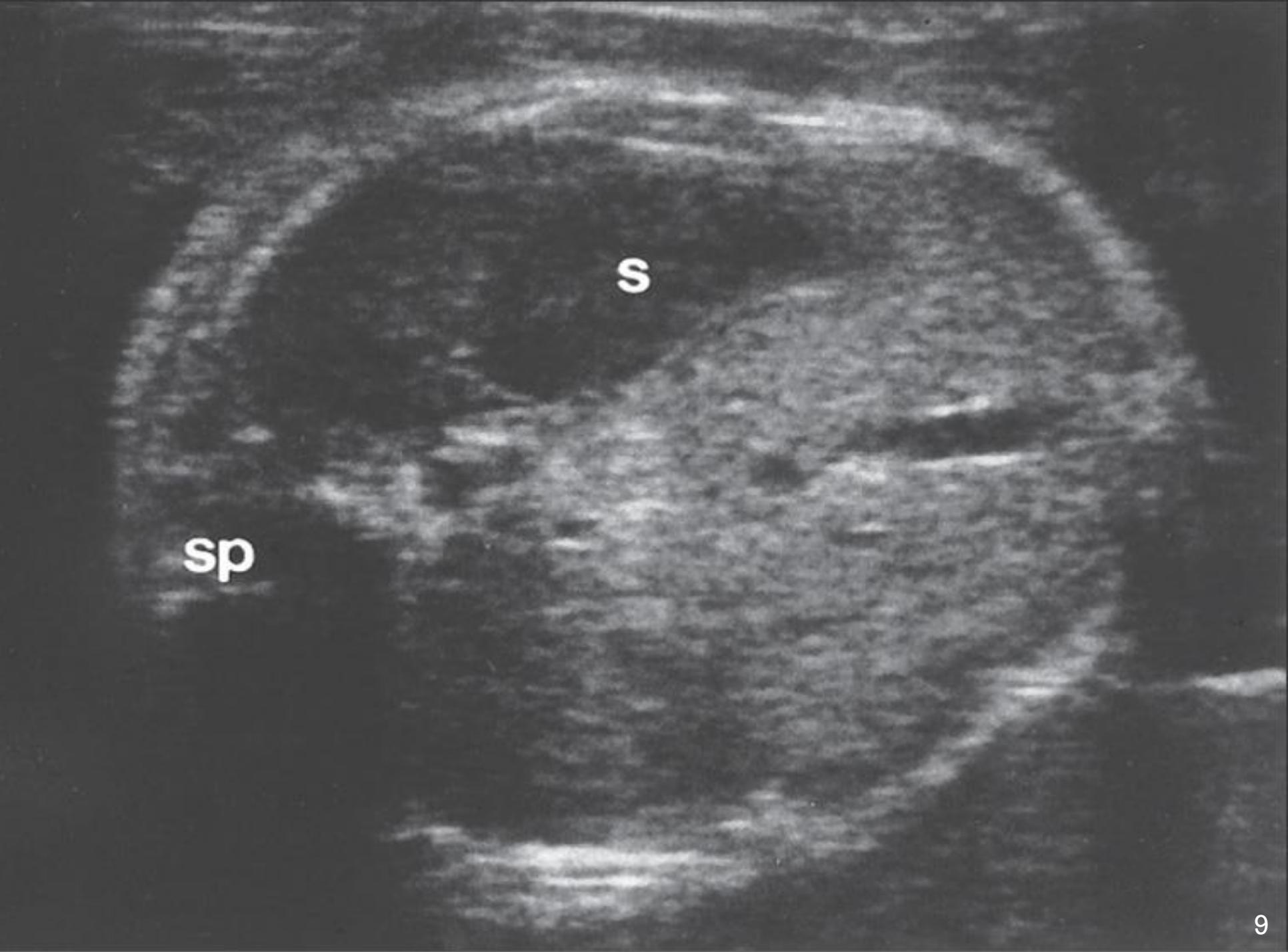
- ◉ **All of these structures are supplied by the IMA**

Sonographic Evaluation of the Abdominal Cavity

Stomach

- **Identified as a fluid-filled structure in the LUQ**
- **Most babies beyond 14 to 16 weeks should have fluid in the stomach**
 - **If no fluid is apparent**
 - **Stomach should be reevaluated in 20 to 30 minutes**
 - **Rule out the possibility**
 - **Central nervous system problem (swallowing disorders)**
 - **Obstruction**
 - **Oligohydramnios**
 - **Atresia**





s

sp

Stomach

- **Esophageal anomalies are the least common problems for nonvisualization of the stomach**
- **Fluid within the stomach should be anechoic (normal)**
- **Echogenic debris may be seen along the dependent wall of the stomach**
 - **May represent**
 - **Vernix**
 - **Protein**
 - **Intraamniotic hemorrhage**

Esophagus

- **Can be visualized in the thorax during the second and third trimesters**
 - **Will see**
 - **Two or more parallel echogenic lines (“multilayered” pattern)**



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RAB 4-8L/OB

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Dr. Moroder ecofetale.com

2.8/ 8.9cm / 46Hz

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GE

esophagus

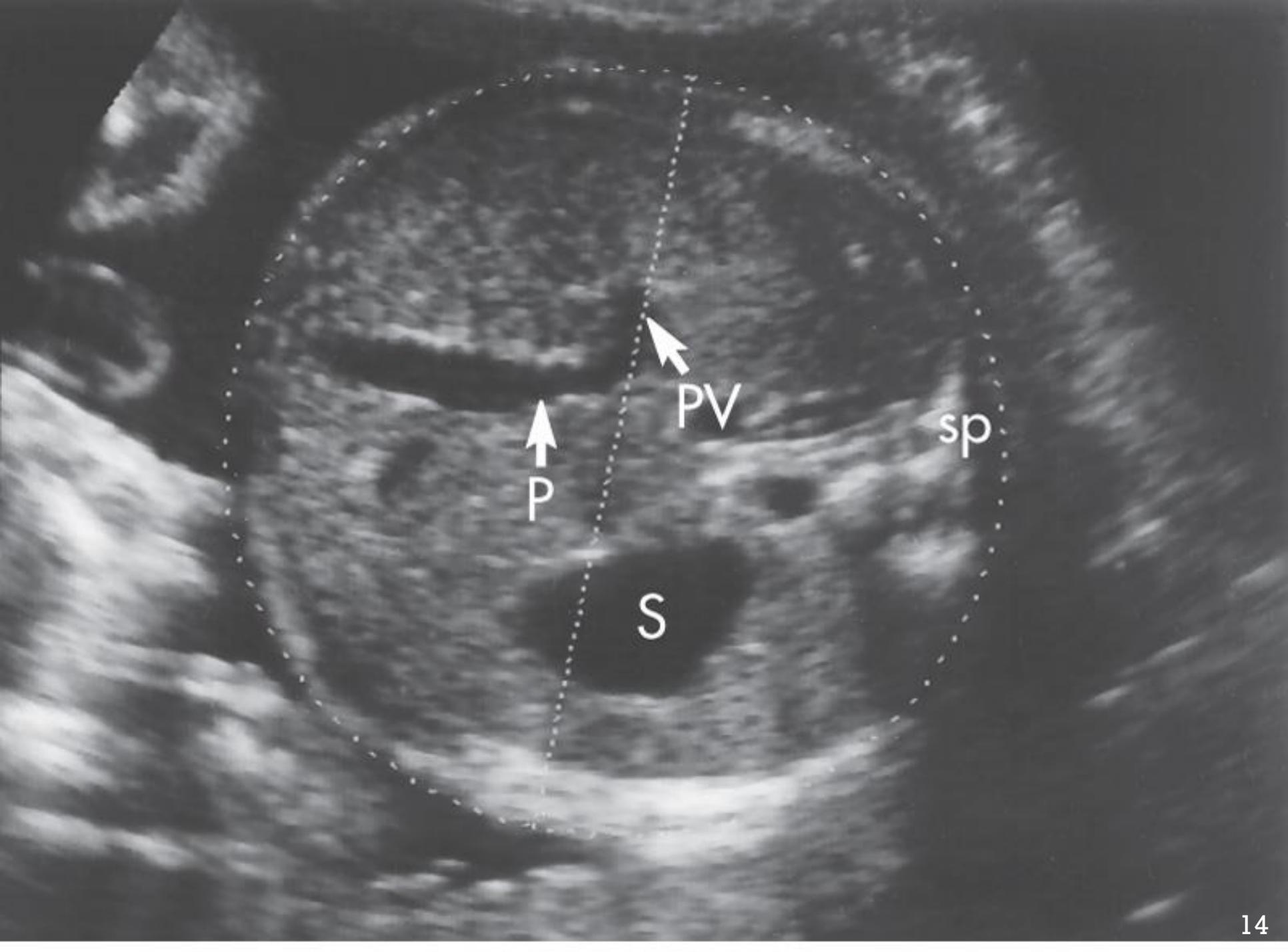
stomach

Cine 283

6.2 sec

Abdominal Circumference

- **Measured at the level of the portal sinus and the umbilical portion of the left portal vein (“hockey stick”)**
- **Avoid oblique scanning of the abdomen**
 - **Incorrect diameter/circumference measurement**
- **Abdomen should be round**
 - **Not oval!!!!**
- **Transducer pressure should not compress the abdominal cavity**

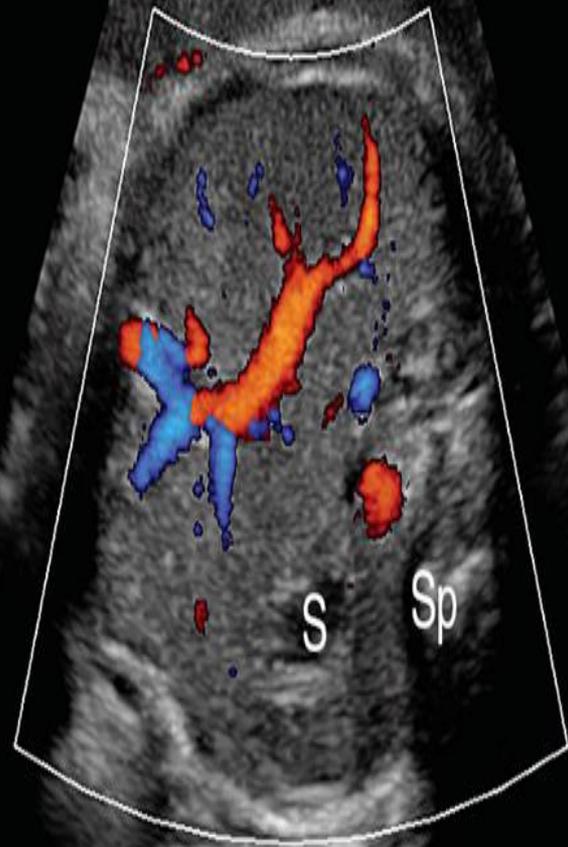


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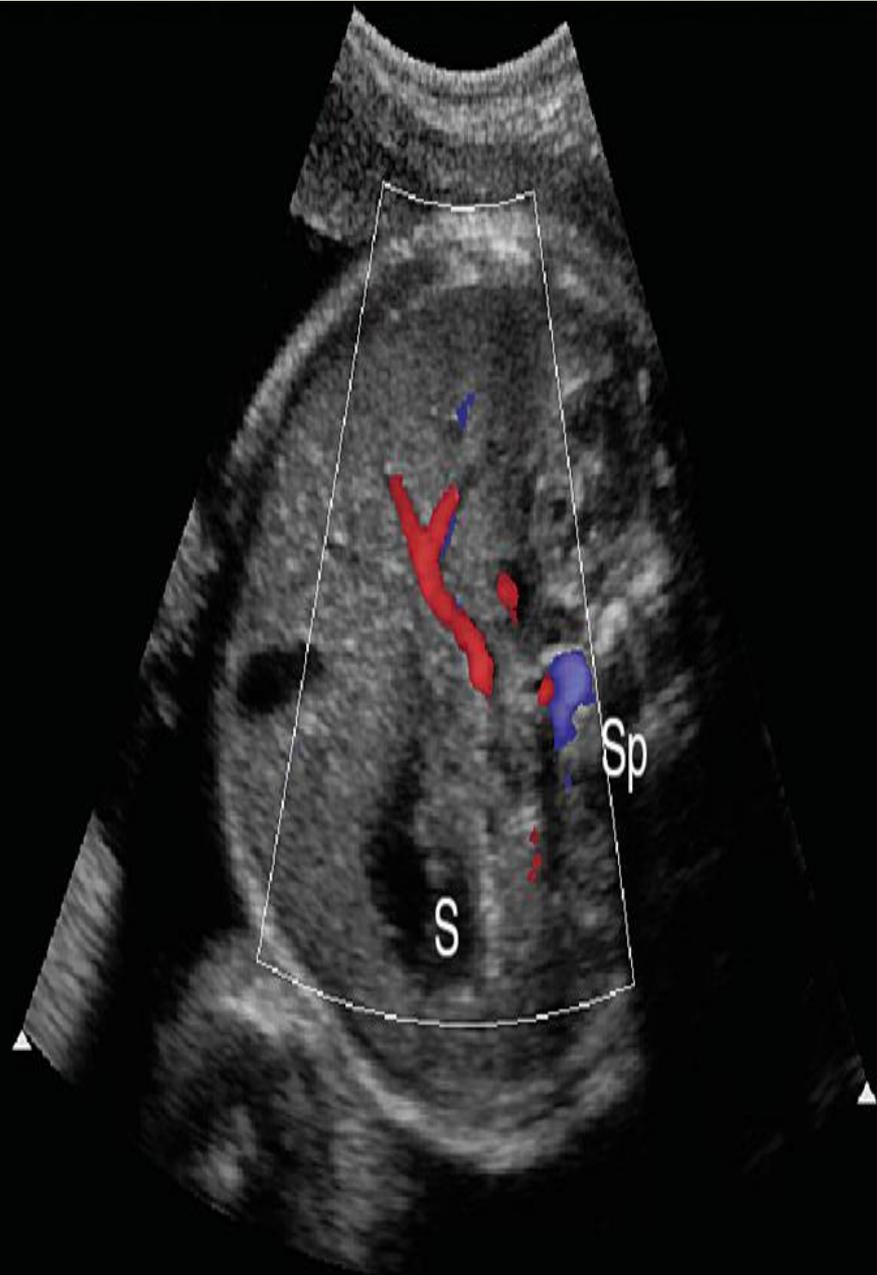
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25-WEEK ABDOMEN

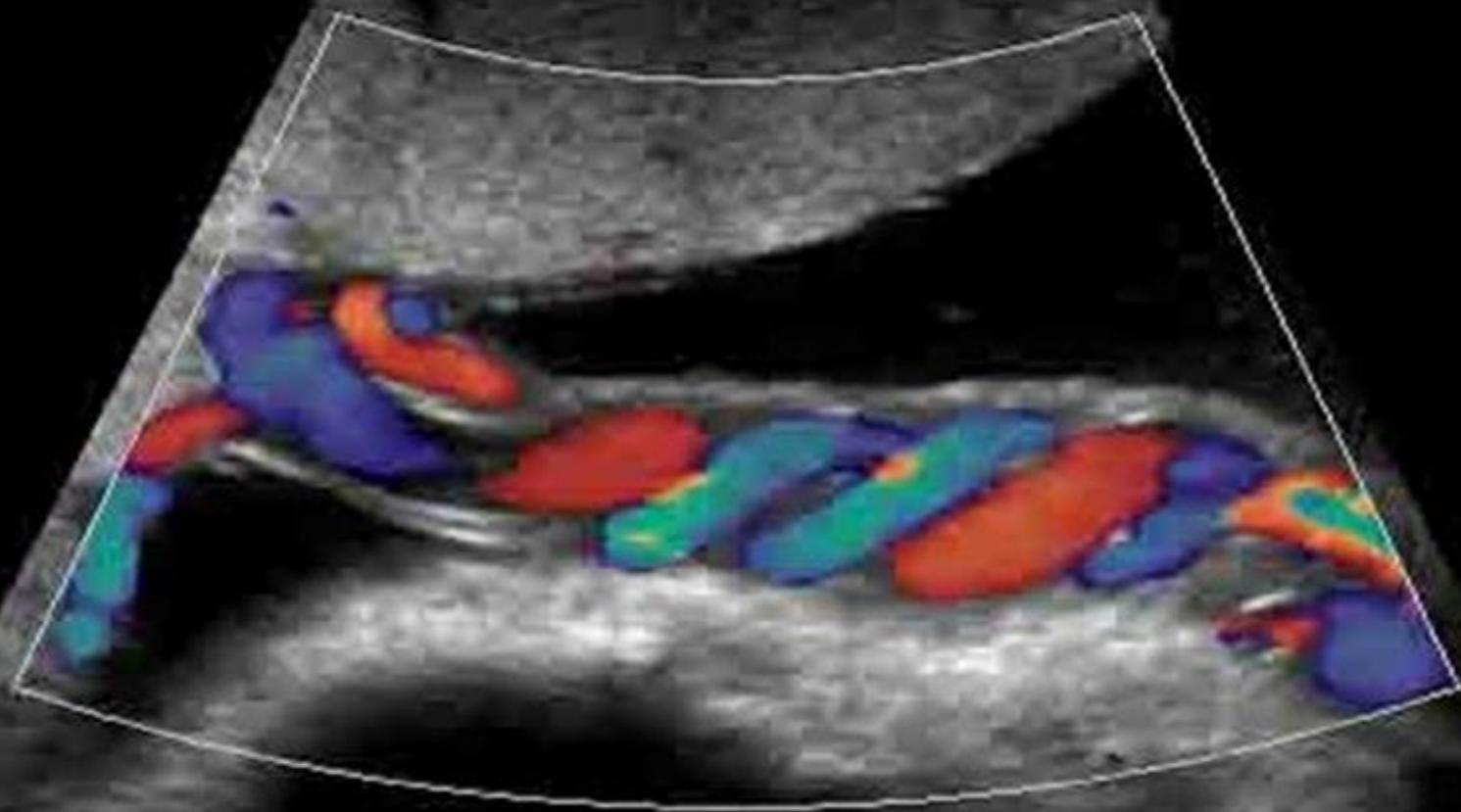


34-WEEK PORTAL VEIN

Umbilical Cord Insertion

- **Umbilical vein courses cephalad in the inferior margin of the falciform ligament**
- **Insertion must be imaged with color as it inserts into**
 - **Fetal abdomen**
 - **Placenta**

HD



Umbilical Cord Insertion

- **Visualization of cord insertion must be made to rule out the presence of**
 - **Omphalocele**
 - **Gastroschisis**
 - **Hernia**
 - **Mass formation**
- **After birth**
 - **Umbilical vein collapses and becomes the ligamentum teres**

Bowel

- **Movement of gastric musculature begins in fourth to fifth month of gestation**
- **Second trimester**
 - **This movement and fetal swallowing result in delivery of increased amniotic fluid volume distally into the small bowel and colon where fluid and nutrients are reabsorbed**

Bowel

- **After 27 weeks**
 - **Peristalsis of small bowel is observed**
- **Normal diameter of small bowel lumen**
 - **≤ 5 mm**
- **Colon is seen near the end of the second trimester**
 - **Long tubular hypoechoic structure with well-defined walls**
 - **Haustral folds help to differentiate it from the small bowel**



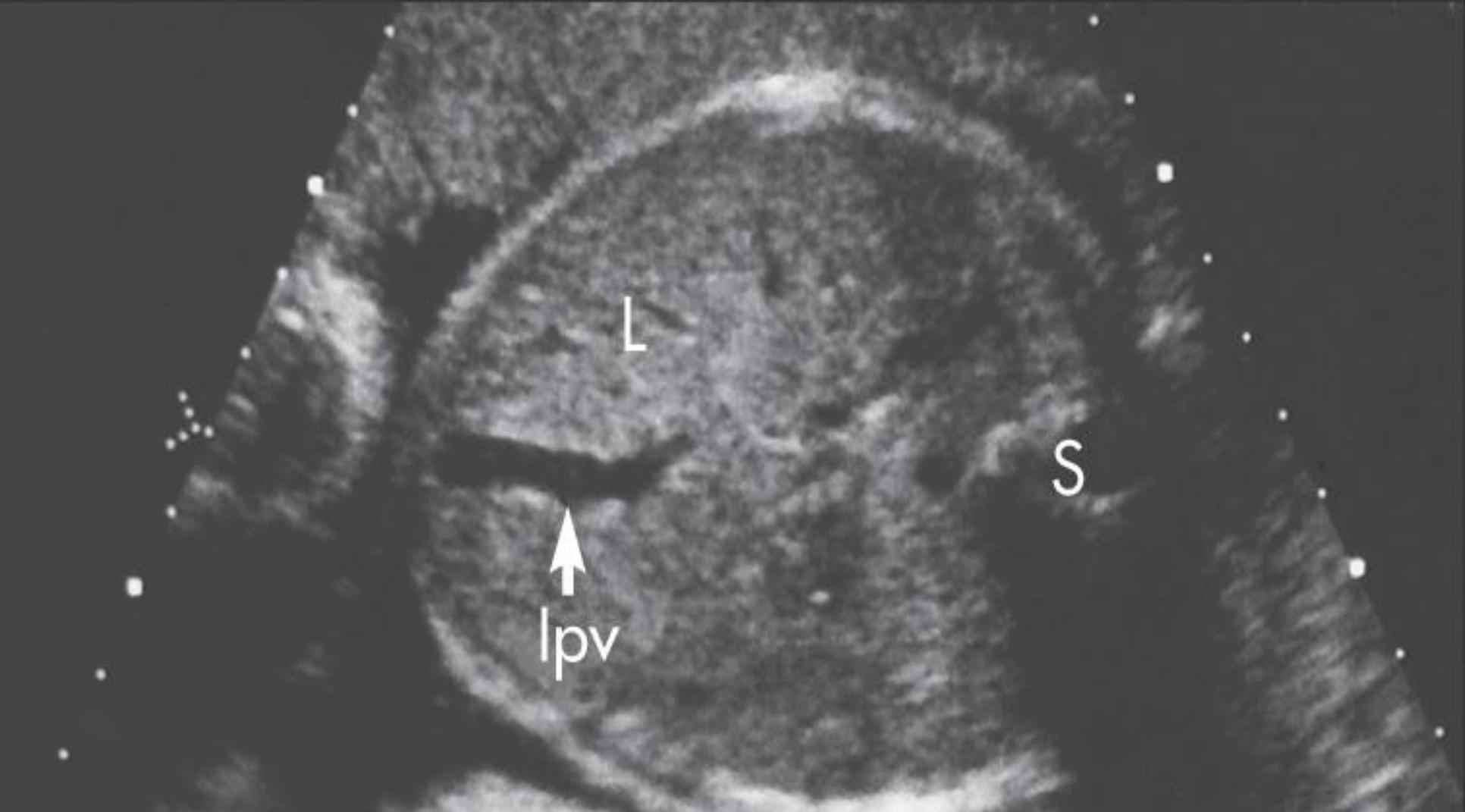
23-week fetus with abdominal ascites surrounding the small bowel (*Sm*)

Bowel

- **Early gestation**
 - **Haustral folds appear as thin linear echoes within the lumen of the colon**
- **Later gestation**
 - **Colon diameter increases**
 - **Folds become longer and thicker**
- **Normal colon diameter**
 - **14 to 18 mm at term**
- **Hypoechoic echoes from the meconium may be seen**
- **Colon does not have peristalsis like the small bowel does**

Hepatobiliary System

- **Fetal liver is relatively large compared to other intraabdominal organs**
- **Gallbladder may be seen after 20 gestational weeks**
- **Fetal pancreas has been seen but is more difficult to routinely recognize because of the lack of fatty tissue within the gland**



31-week fetus outlining the course of the left portal vein (*lpv*) at its entrance into the liver

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50DB C3 E4
HDI

29 WEEKS
PANCREAS



pancreas (arrows)

Abnormalities of the Hepatobiliary System

**Abnormalities of the liver,
gallbladder, pancreas, and
spleen are rare**

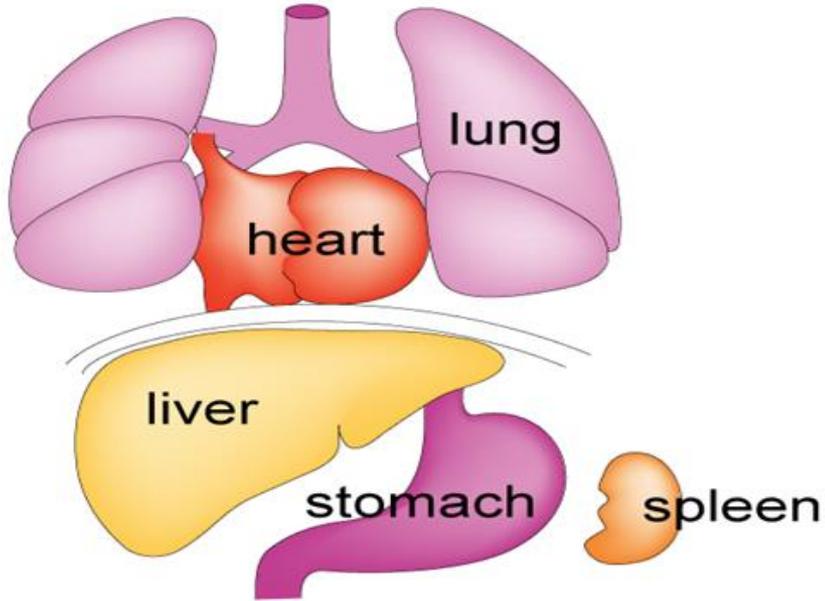
Liver

- **Rarely affected by isolated hepatic lesions**
 - **Parenchyma cysts**
 - **Hemangiomas**
 - **Hamartoma (uncommon)**
 - **Hepatoblastoma (uncommon)**
 - **Teratoma (uncommon)**
 - **Adenoma (uncommon)**
 - **Metastases from neuroblastoma (uncommon)**
- **Most of these tumors appear as hypoechoic solid masses within the liver**
- **Cystic components also have been reported as mixed with the solid mass**

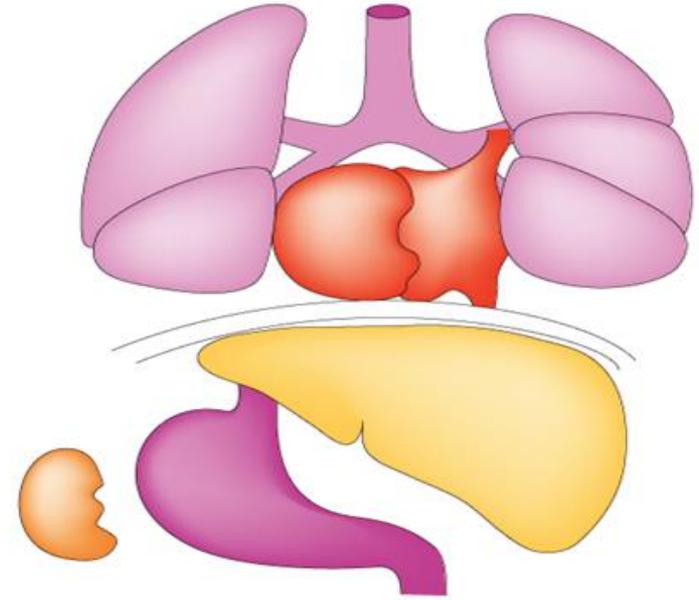
Situs Inversus

- **May present as total reversal of thoracic and abdominal organs or as partial reversal (mirror image)**
- **Partial situs inversus**
 - **More severe disorder**
 - **May develop in two different combinations of organ reversals**
 - **Thoracic viscera usually reversed**
 - **Abdominal viscera may or may not be reversed**

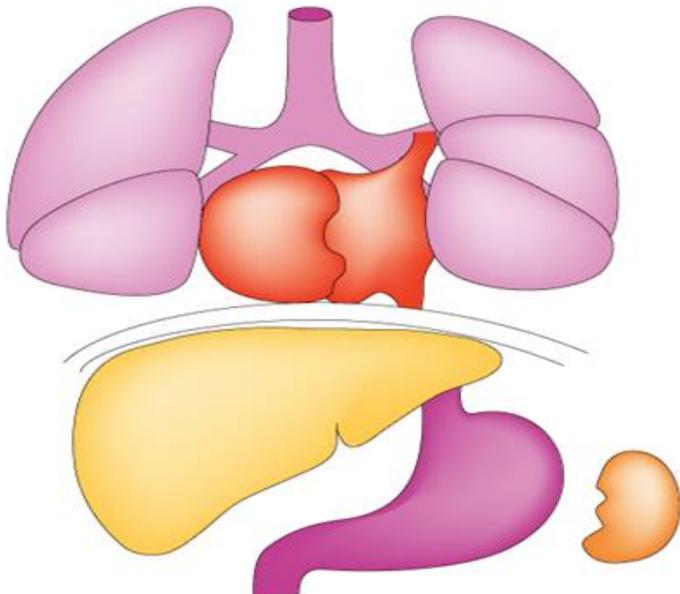
situs solitus



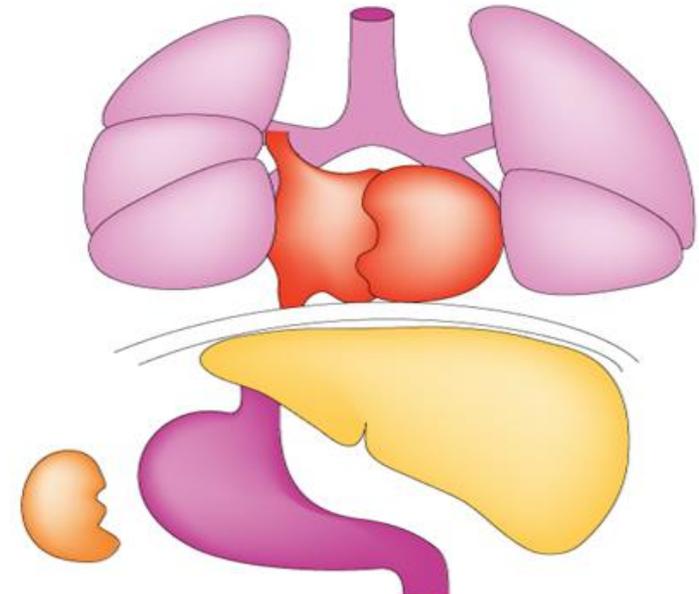
situs inversus totalis



situs inversus thoracalis



situs inversus abdominalis

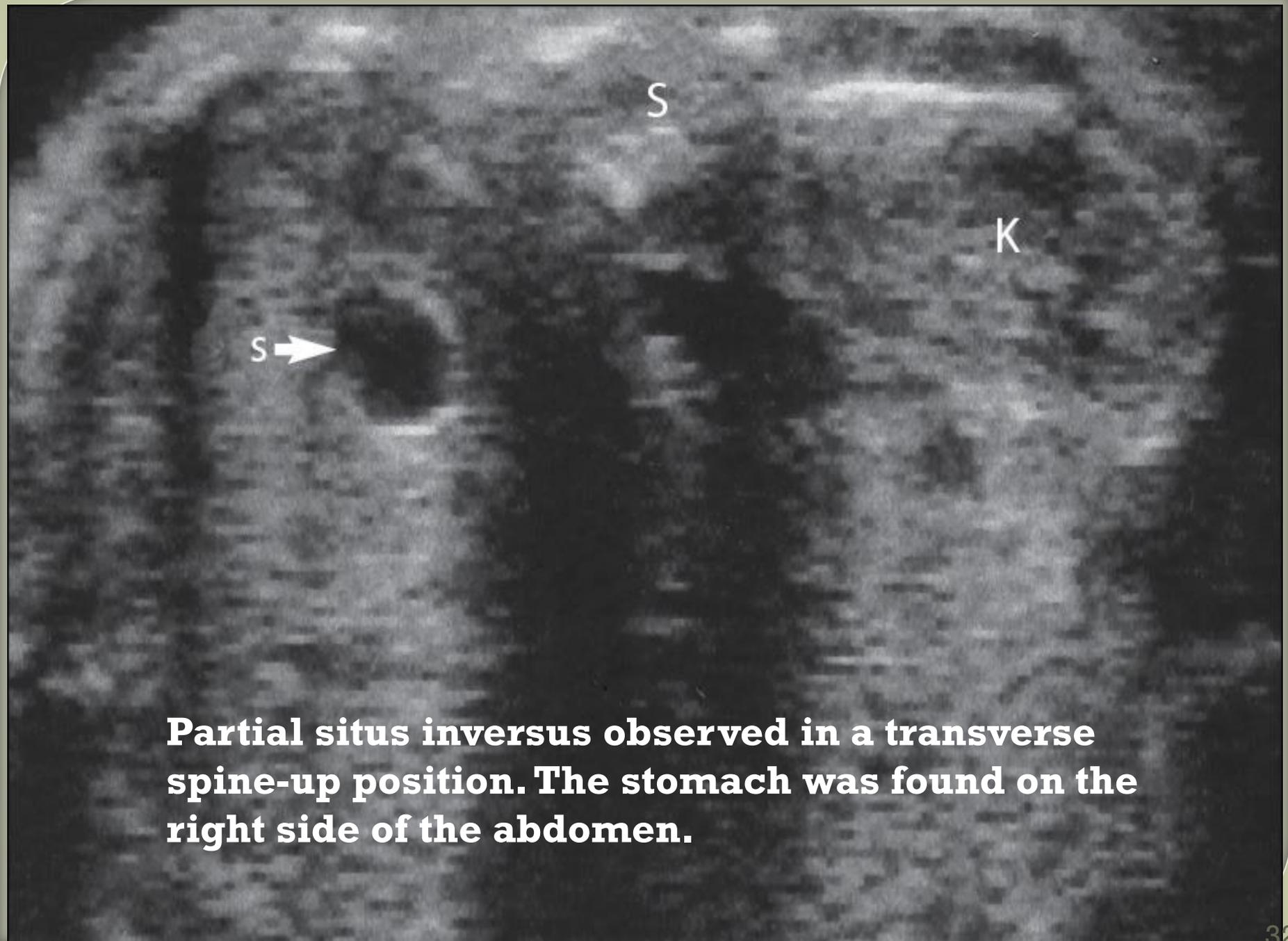


Situs Inversus

- **Partial situs divided into asplenia and polysplenia**
- **Asplenia (absence of spleen):**
 - **Abnormally positioned stomach and gallbladder**
 - **More centrally positioned liver**
 - **Abnormal position of aorta and IVC on same side**

Situs Inversus

- ◉ **Polysplenia represented as transposition of liver, spleen, stomach, and absence of gallbladder**
- ◉ **Interruption of IVC and azygos vein directly posterior to heart and in front of spine**
- ◉ **At least two spleens present along greater curvature of stomach**
- ◉ **Heart block is common in polysplenia syndrome**



Partial situs inversus observed in a transverse spine-up position. The stomach was found on the right side of the abdomen.

Situs Inversus

- **Cardiac malformations**
 - **Common in asplenia syndrome (99%)**
 - **Less frequent in polysplenia syndrome (90%)**
- **Infant with total situs inversus usually has normal outcome**
- **Mortality rate for partial situs inversus is extremely high**
 - **90-95% with asplenia syndrome**
 - **80% with polysplenia syndrome**

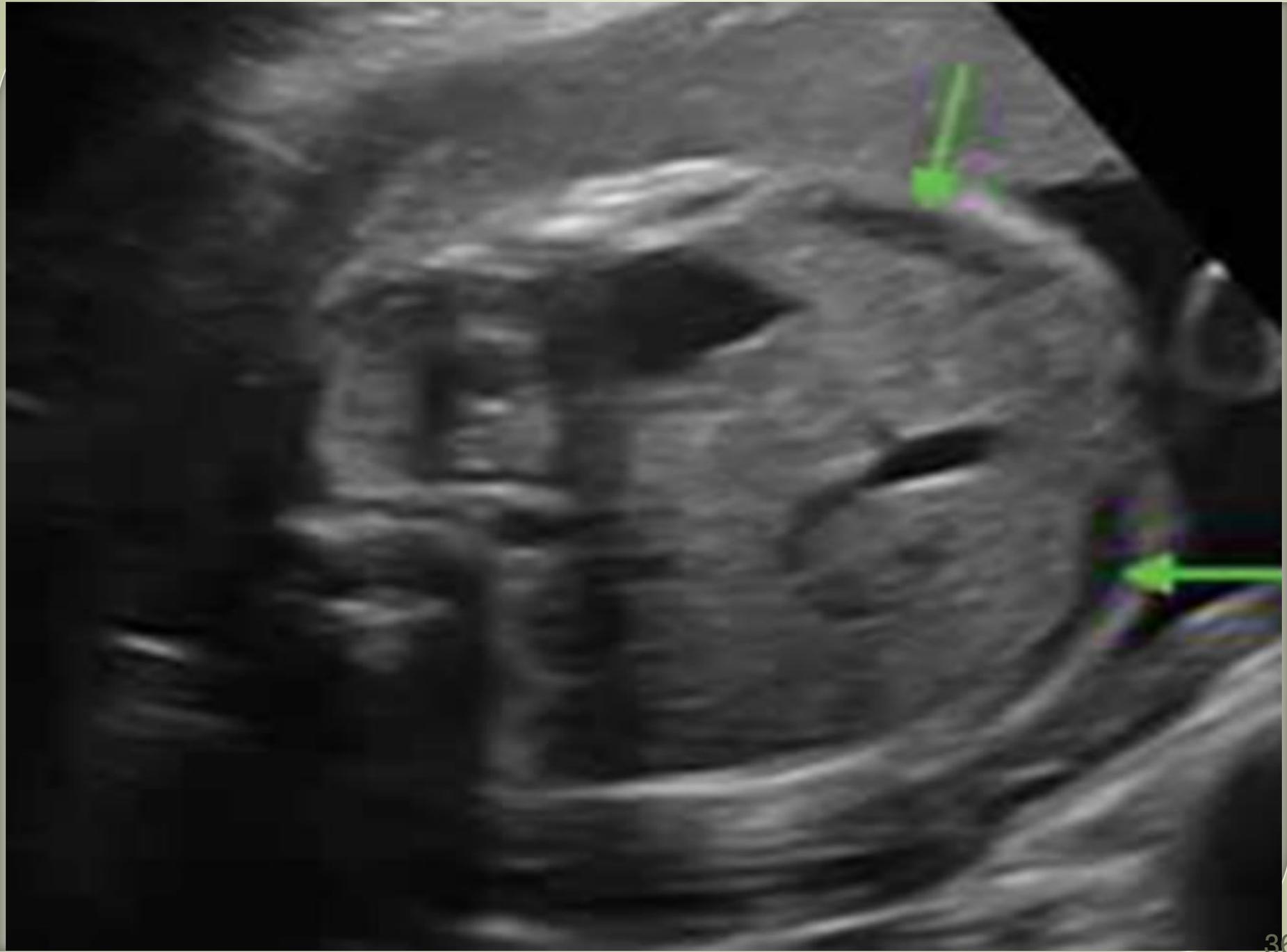
Situs Inversus

○ Sonographic findings:

- **Total situs inversus (right-sided heart axis and aorta; transposition of liver, stomach, spleen; left-sided gallbladder)**
- **Partial situs inversus (right-sided stomach, left-sided liver); dextrocardia with normal stomach position**
- **Other anomalies to check for include gastrointestinal, genitourinary, and neural tube defects**

Pseudoascites

- **Sonolucent band near the anterior abdominal wall**
 - **Commonly identified fetuses >18 weeks**
 - **Normal musculature surrounding the abdominal wall**
- **True ascites is identified within the peritoneal recesses**
- **Pseudoascites is always confined to an anterior or anterolateral aspect of the fetal abdomen**



Gallbladder

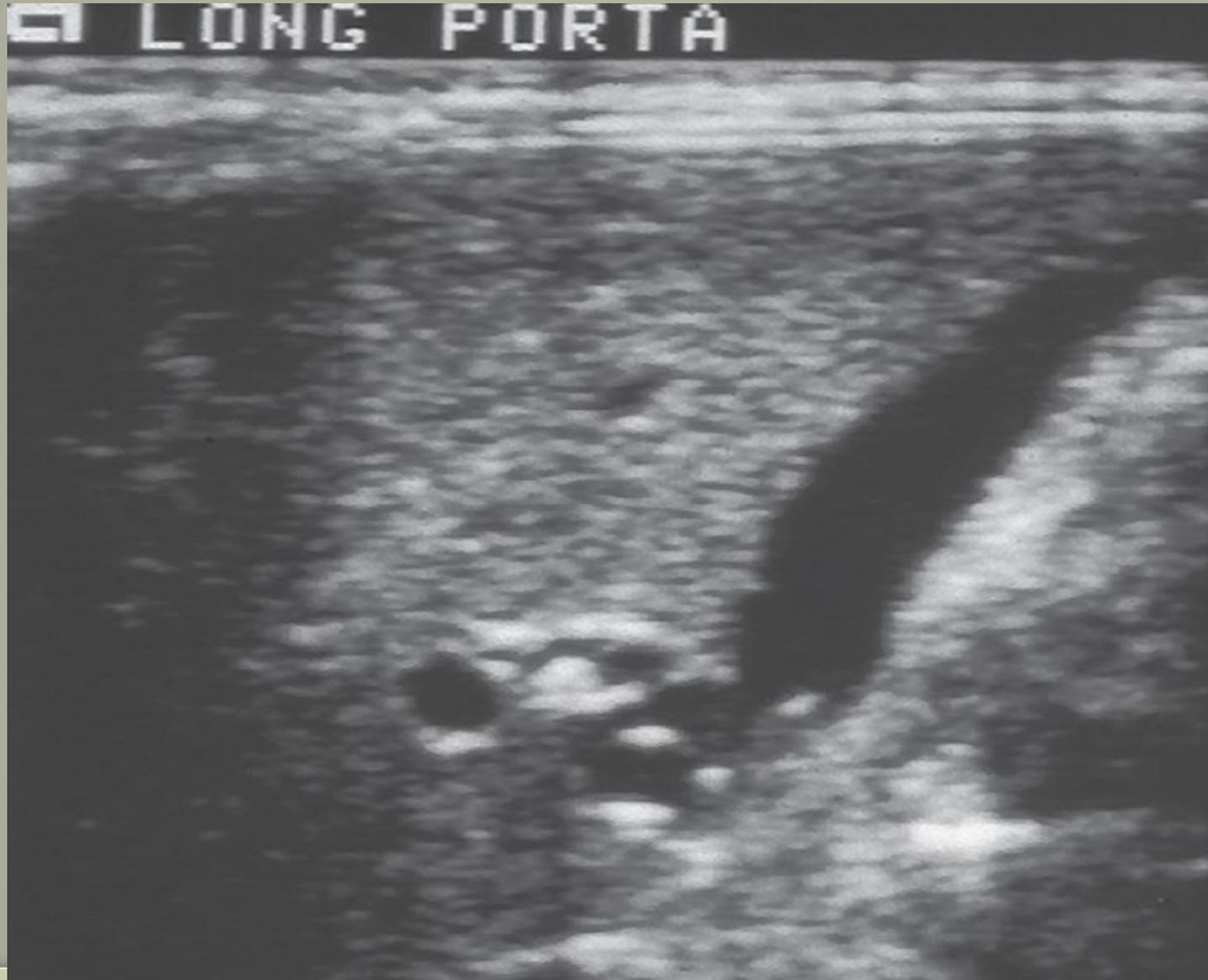
○ **Cholelithiasis may be identified when calcifications are found within the gallbladder**

- **These gallstones resolve spontaneously in utero or in the childhood period**

○ **Choledochal cyst (dilation of the common bile duct)**

- **May be differentiated when a cystic mass is identified adjacent to the fetal stomach and gallbladder**
- **May be confused with malformation of the stomach or bowel or duodenal atresia**
- **May be associated with intermittent biliary obstruction and severe biliary cirrhosis**

Neonate with gallstones



Gallbladder

○ **Sonographic findings:**

- **Gallbladder is a teardrop shaped anechoic structure located in the RUQ**
- **Ability to visualize fetal gallbladder increases with gestational age**
- **Cholelithiasis – echogenic calcifications visualized within gallbladder**
- **Choledochal cyst – close proximity of cyst to neck of gallbladder, enlarges with gestational age, connection to adjacent bile duct**

Pancreas

- ◉ **Difficult to routinely visualize in utero**
- ◉ **Pancreatic cysts may present**
 - **Midline cystic masses within abdomen**

Spleen

- **Asplenia (absence of the spleen)**
 - **May be identified**
 - **Associated with congenital heart disease**
 - **Polysplenia/asplenia syndrome should be considered**
- **Congenital splenic cysts are rare but have been reported**
- **Splenomegaly may be seen**
- **The spleen, like the liver, may enlarge in fetuses with Rh-immune disease**

Abnormalities of the Gastrointestinal Tract

**Majority of GI malformations
are correctable after birth**

Esophagus, Stomach, and Duodenum

- **Esophagus may be seen after fluid is swallowed**
 - **Fluid passes from esophagus to stomach**
 - **Obstruction of normal swallowing may occur**
 - **Atretic (closure/absence)**
 - **Obstructive process**

Esophagus, Stomach, and Duodenum

- ◉ **Membrane that covers lumen and intestinal loops enlarges above the obstruction**
 - **Bowel loops below the atresia are narrowed (stenotic)**
- ◉ **Enlargement of bowel proximal to the obstruction is apparent on ultrasound**
- ◉ **Blockage results in the back-up of amniotic fluid and hydramnios**

Atresias

- ① **Develops when a portion of bowel grows and infarcts**
- ① **Occurs anywhere in the GI tract**
- ① **Polyhydramnios is present**

Nonvisualization of the Stomach

◎ Causes

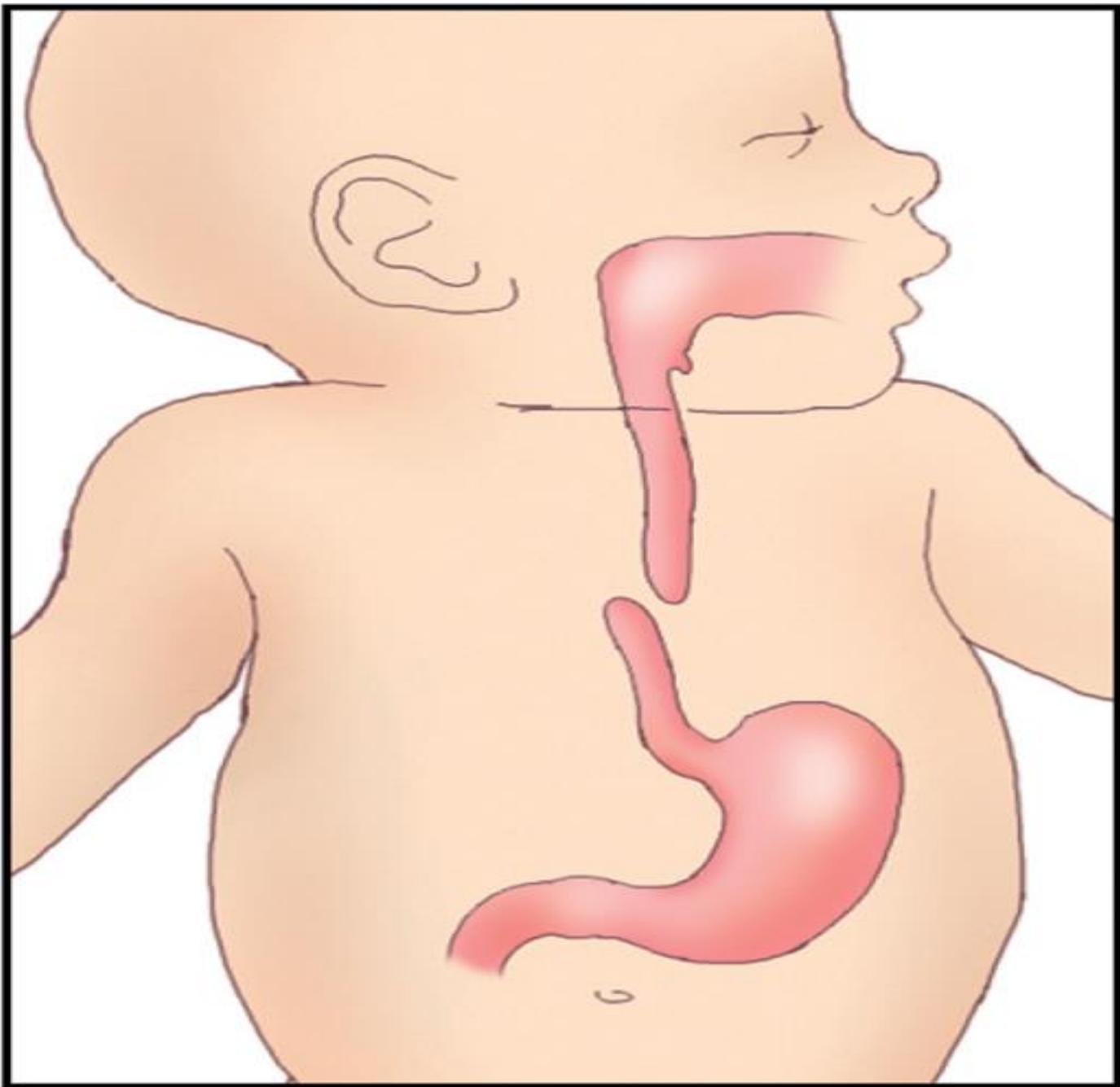
- Esophageal atresia or tracheoesophageal fistula**
- Diaphragmatic hernia**
- Facial cleft**
- Central nervous system disorder**
- Other swallowing disorders**
- Oligohydramnios from other causes**

Esophageal Atresia

- **Congenital blockage of the esophagus**
- **Most common form occurs in conjunction with a fistula communicating between the trachea and esophagus (tracheoesophageal fistula)**
 - **Allows passage of fluid into the stomach**

Esophageal Atresia

- ◉ **In some cases a fistula is not present**
 - **Fluid will not reach the stomach**
 - **Stomach will not be visualized**
- ◉ **Combination of the following is suggestive of esophageal atresia**
 - **Polyhydramnios**
 - **Absent stomach**

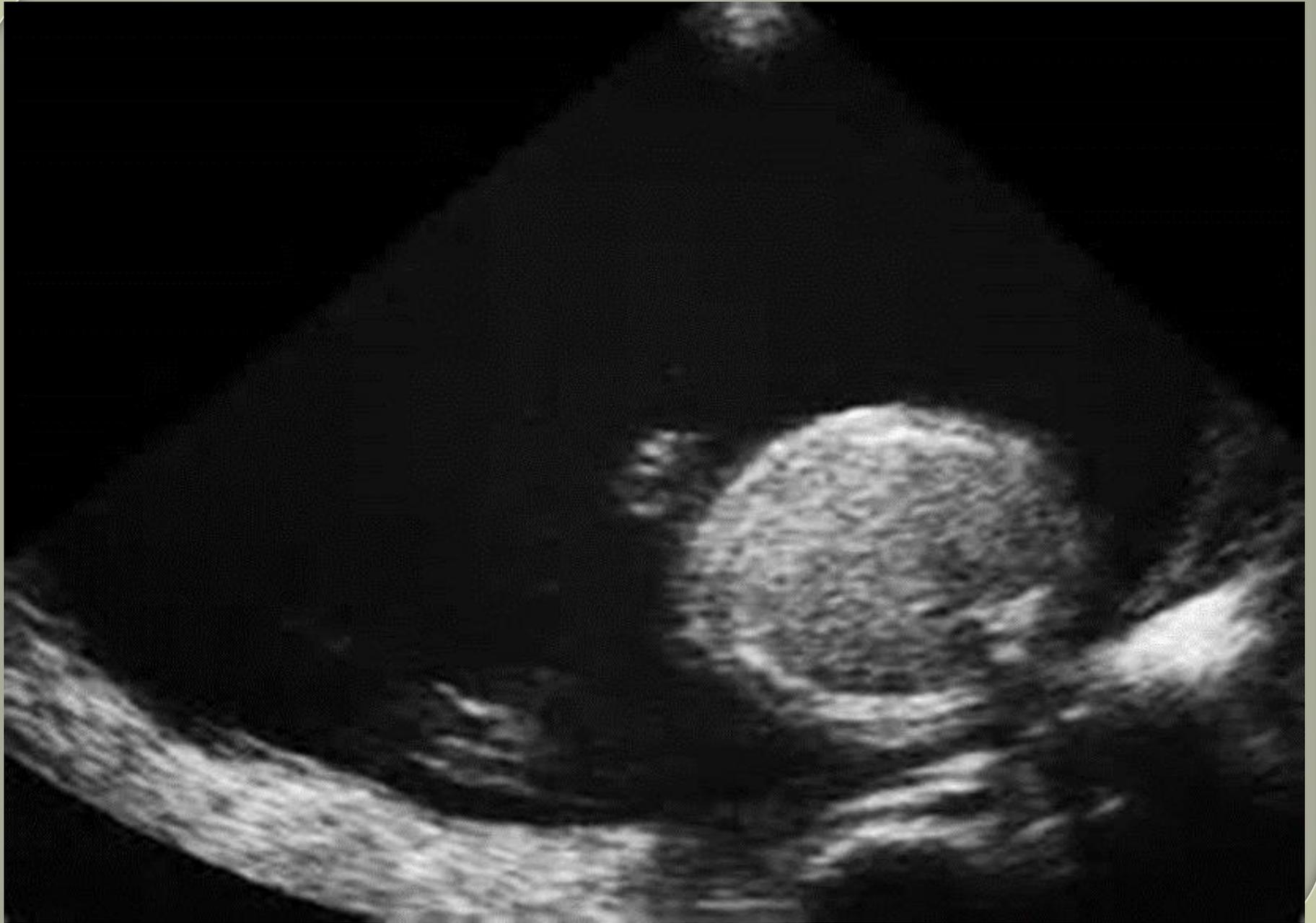


Esophageal Atresia

- **In more than half of the cases**
 - **Stomach is present because a fistula**
- **Polyhydramnios may be present**
 - **Impaired reabsorption of swallowed fluid**

Esophageal Atresia

- **Coexisting anomalies are common**
- **Most common**
 - **Anorectal atresia**
- **Others include**
 - **Vertebral defects**
 - **Heart defects**
 - **Renal anomalies**
 - **Limb anomalies [VACTERL])**
- **IUGR present in 40% of the cases**



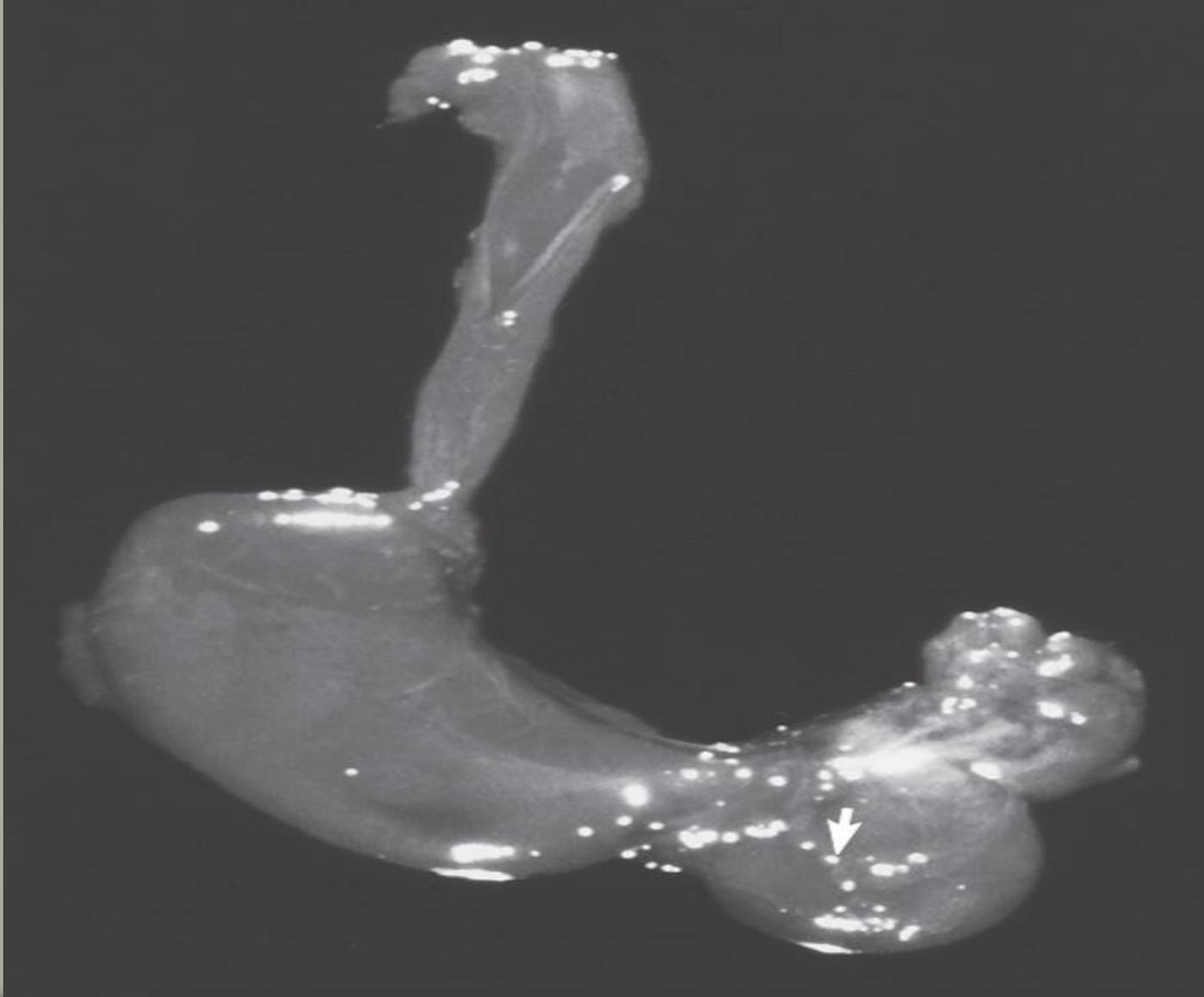
Duodenal Atresia

- **Blockage of the duodenal lumen**
 - **Membrane prohibits passage of swallowed fluid**
- **Atresia or narrowing of the bowel segment below the obstruction occurs**
- **Amniotic fluid fails to move beyond the obstruction**
 - **Backs up in the duodenum and stomach**

Duodenal Atresia

- **Two sonolucent structures**
 - **(stomach and duodenum)**
communicate
- **“Double Bubble Sign”**
- **Polyhydramnios is almost always seen later in pregnancy**
- **Most cases**
 - **Found distal to the ampulla**

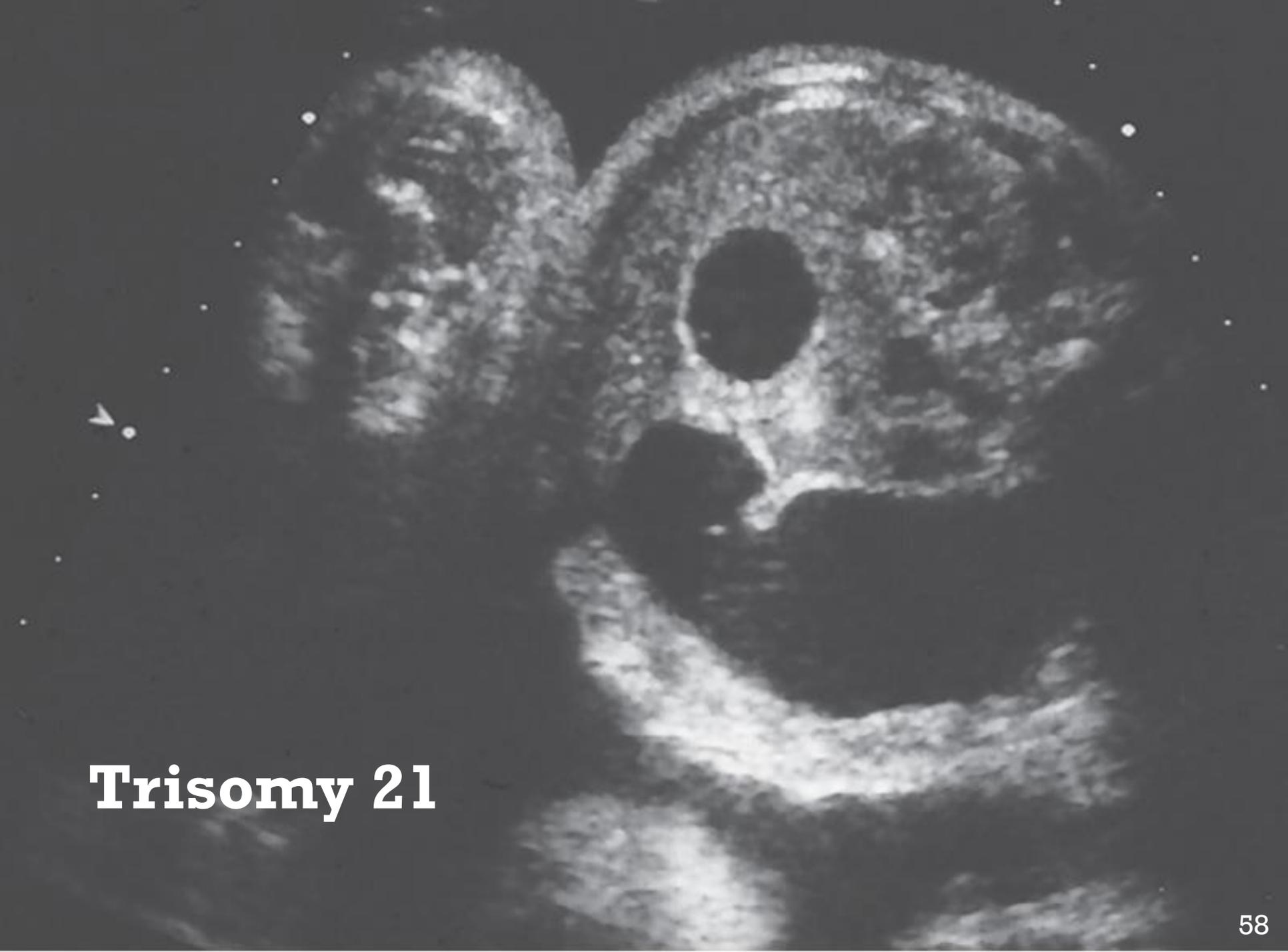
**Neonate with trisomy 21 (Down syndrome)
Narrowing at the duodenum (*arrow*)**





Duodenal Atresia

- **About 30% have trisomy 21**
- **Cardiovascular anomalies are frequent**
- **Anomalies occur in approximately 50%**
 - **Genitourinary anomalies**
 - **(horseshoe kidney, ectopic kidneys)**
- **Other GI abnormalities may be present**
 - **Imperforate anus**
 - **Atresia of the small bowel**
- **Esophageal atresia also may be found**

A black and white ultrasound image of a fetus. The fetus is positioned centrally, with its head at the top. The facial features are visible, including the eyes, nose, and mouth. There is a noticeable abnormality in the facial structure, specifically a cleft or gap in the upper lip and palate area, which is characteristic of a condition like Trisomy 21. The background is dark, and the fetus is highlighted in shades of gray.

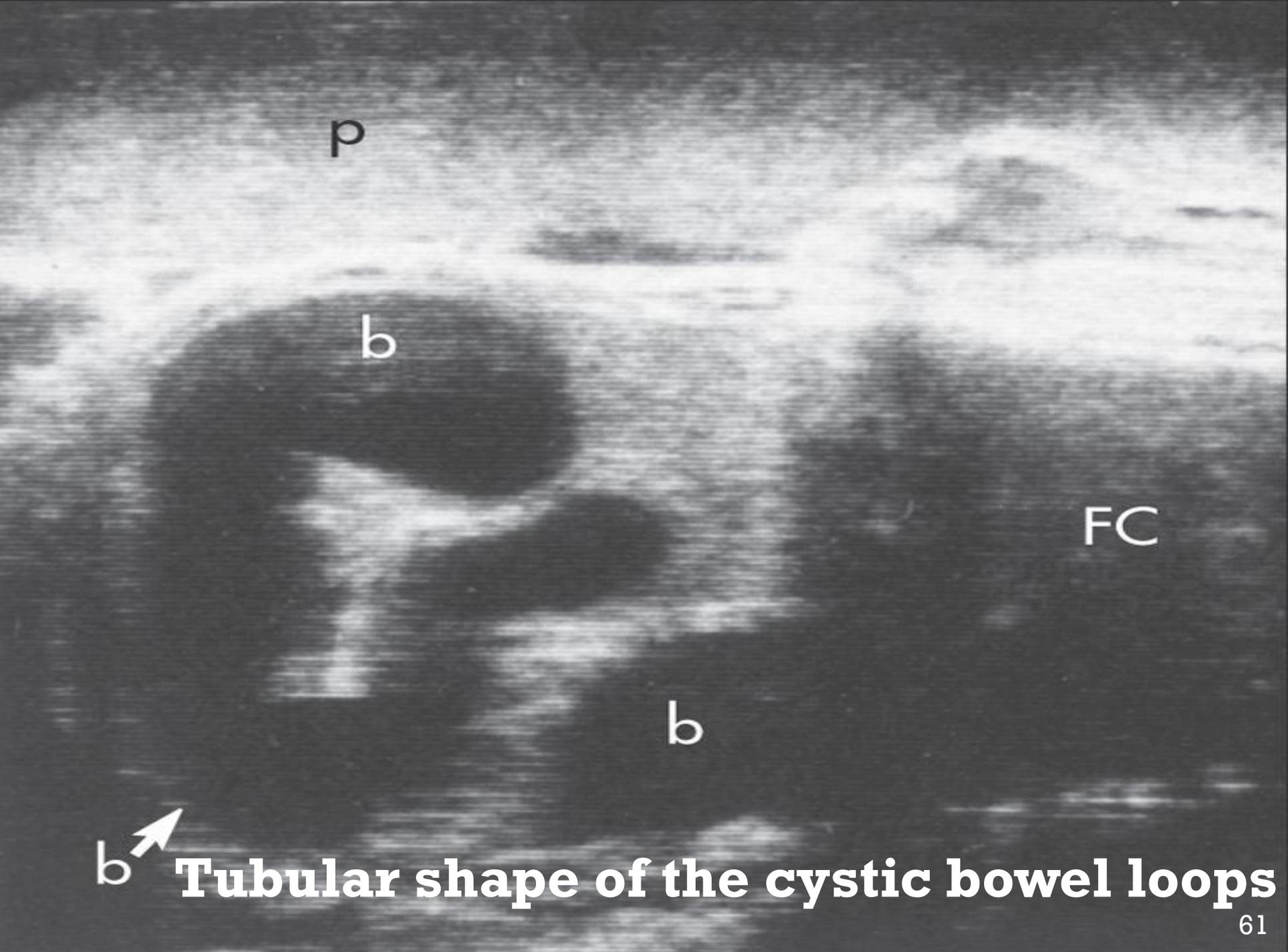
Trisomy 21

Duodenal Atresia

- ◉ **Symmetric growth restriction commonly occurs**
- ◉ **Amniotic fluid AFP values are commonly elevated**
 - **Due to faulty swallowing**
- ◉ **Infants require immediate surgery after birth to connect the stomach to the jejunum**
 - **Bypassing the obstruction**

Intestinal Obstructions

- **Jejunioileal atresia**
 - **Occurs in 1 in 3000 to 5000 births**
 - **Thought to be secondary to a vascular accident**
 - **Either sporadic or secondary to volvulus or gastroschisis**
 - **Entire length of bowel subject to obstruction**
- **Appears as multiple cystic structures**
 - **(more than two)**



p

b

FC

b

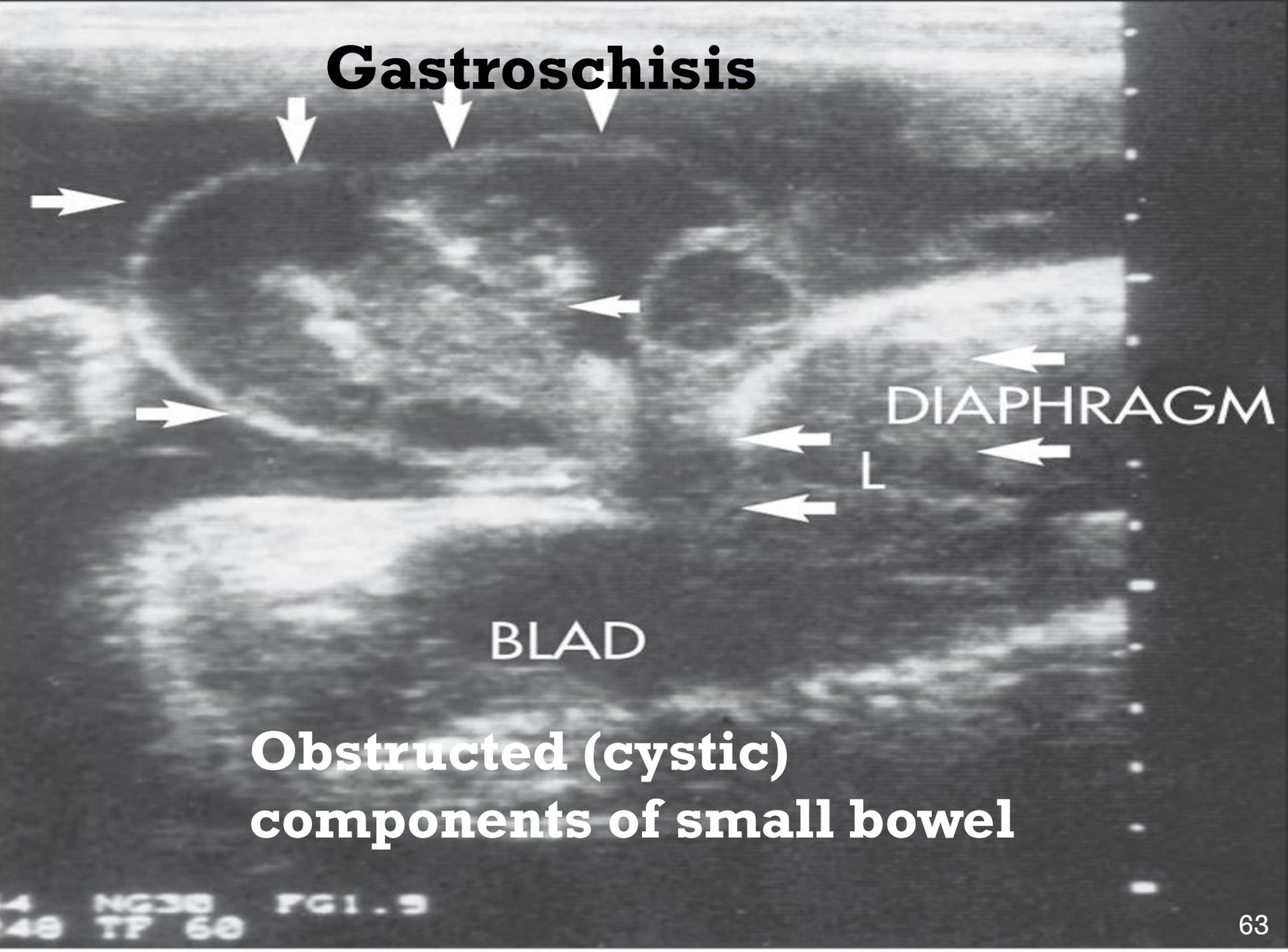
b 

Tubular shape of the cystic bowel loops

Intestinal Obstructions

- **Should be suspected**
 - **Clear cystic structures found in the pelvis**
- **In some cases**
 - **Echoes within the bowel**
 - **But may represent normal meconium patterns**
- **Vascular restriction may lead to obstruction secondary to a gastroschisis**

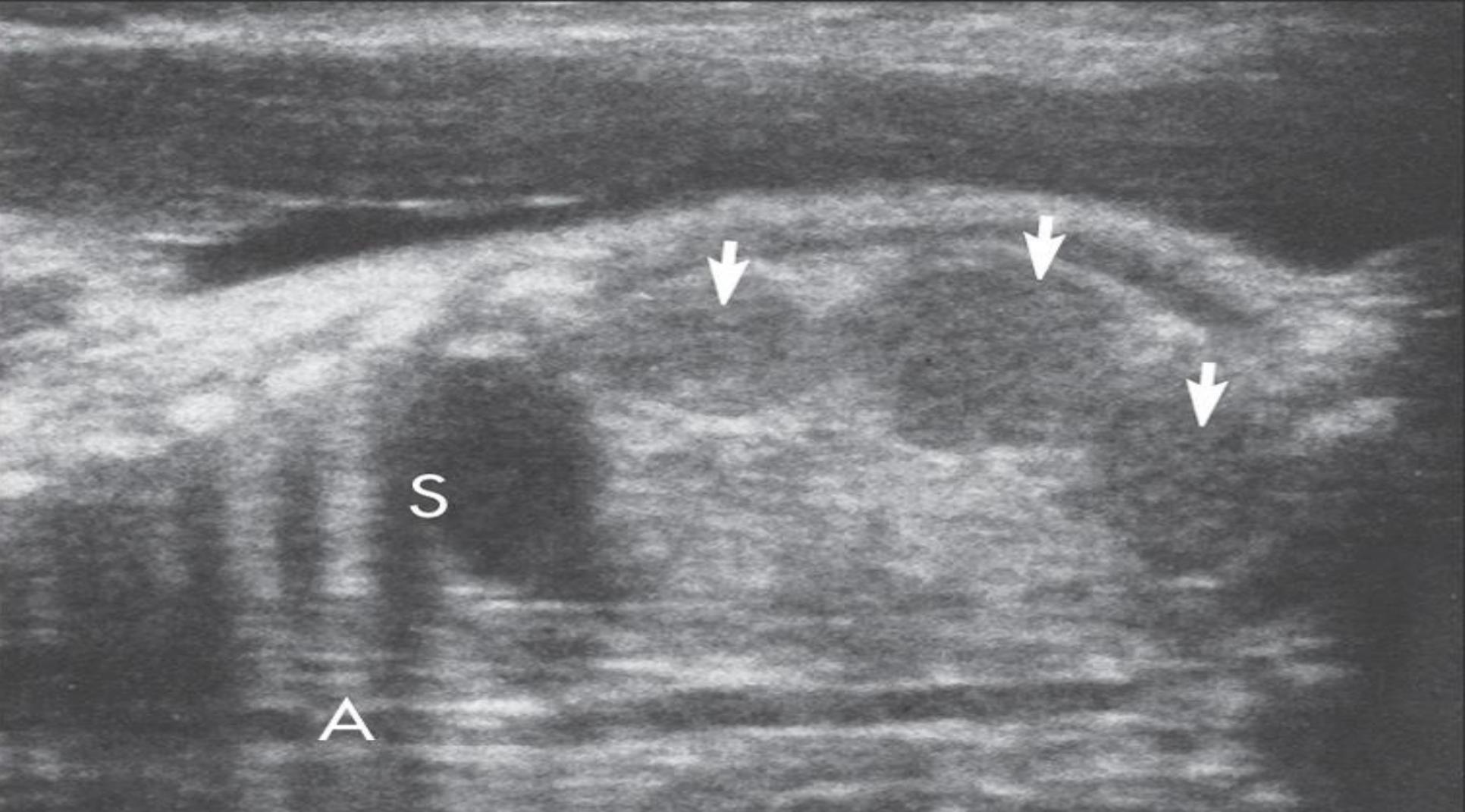
Gastroschisis



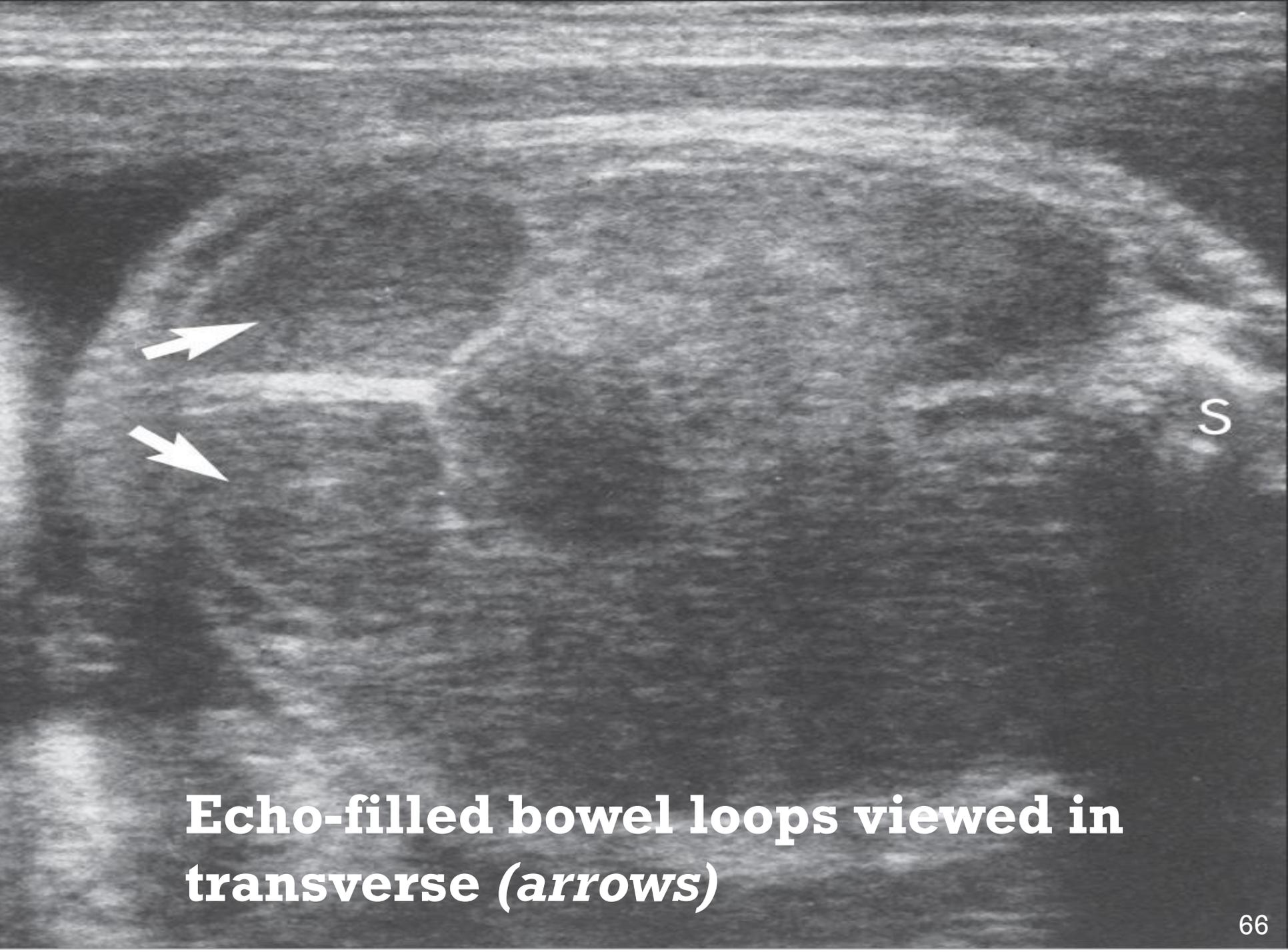
**Obstructed (cystic)
components of small bowel**

Meconium Ileus

- **Small-bowel disorder with presence of thick meconium in the distal ileum**
- **Earliest manifestation of cystic fibrosis**
- **Third most common form of bowel obstruction**
 1. **Atresia**
 2. **Malrotation**
- **Most cases occur in newborns with cystic fibrosis**
 - **Autosomal-recessive condition**



Bowel obstruction in a fetus with cystic fibrosis
Bowel loops are filled with meconium (*arrows*)



Echo-filled bowel loops viewed in transverse (*arrows*)

Meconium

- **Begins to accumulate in bowel in the second trimester**
 - **Can be seen as tiny echogenic reflections within the peristaltic small bowel**
- **Because the colon does not exhibit peristalsis in utero**
 - **Meconium remains suspended at the rectum**
- **Anal sphincter prevents passage of meconium (meconium plug) into the amniotic fluid**
 - **Unless fetus is stressed or traumatized**



L382 30HZ
DEPTH = 120
UCSDMC /V
PWR = -3dB
50dB 1/3/0
GAIN = -6dB

Meconium accumulates as echogenic reflections (notice shadowing)

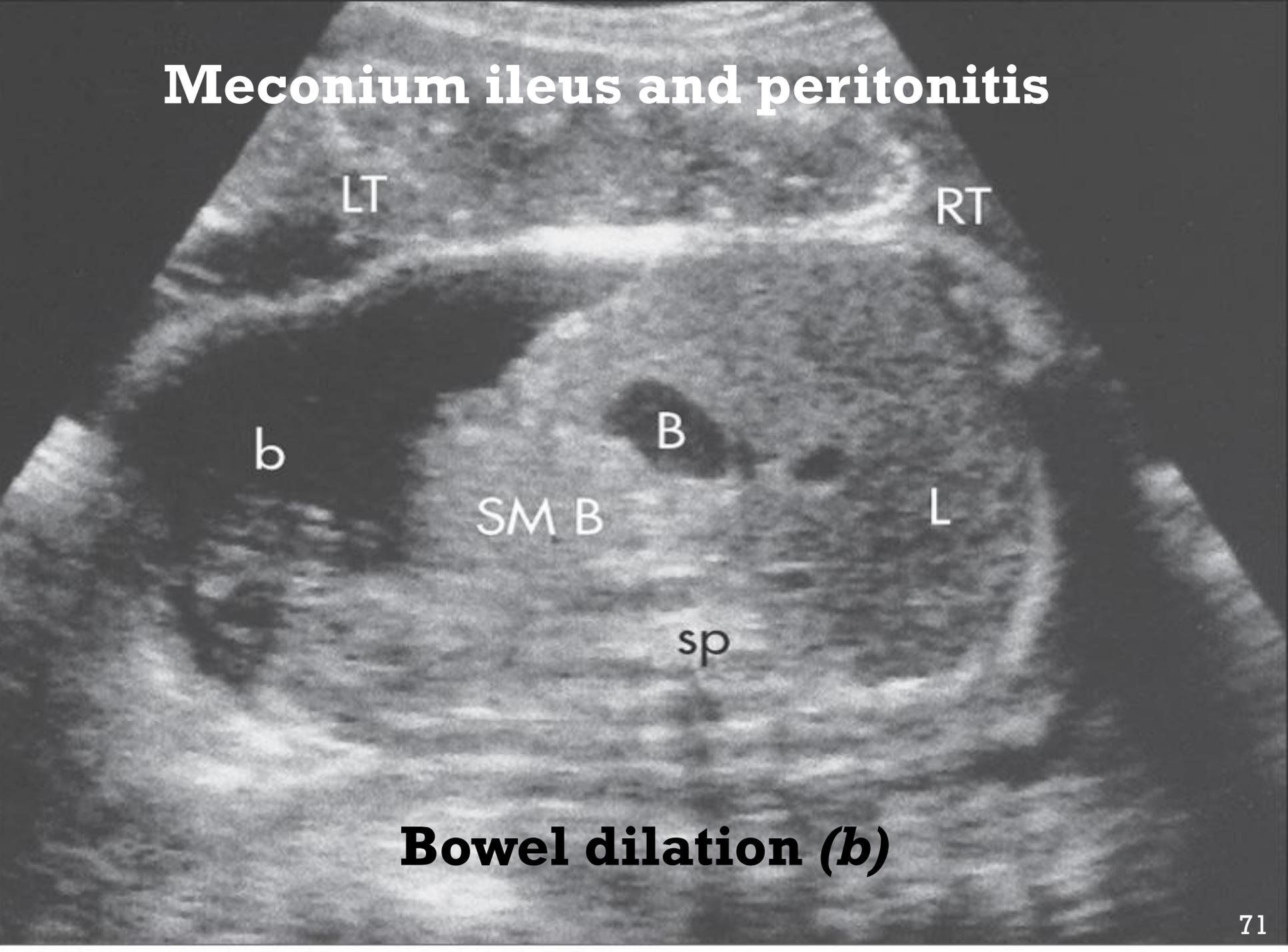
Meconium Ileus

- **Ileum dilates because of impacted meconium**
 - **Appears echogenic**
- **Increased production of mucus by the GI organs and electrolyte imbalance explains the overproduction of meconium (characteristic of cystic fibrosis)**
- **Important to note**
 - **Normal small bowel may appear echogenic during the second trimester**

Meconium Ileus

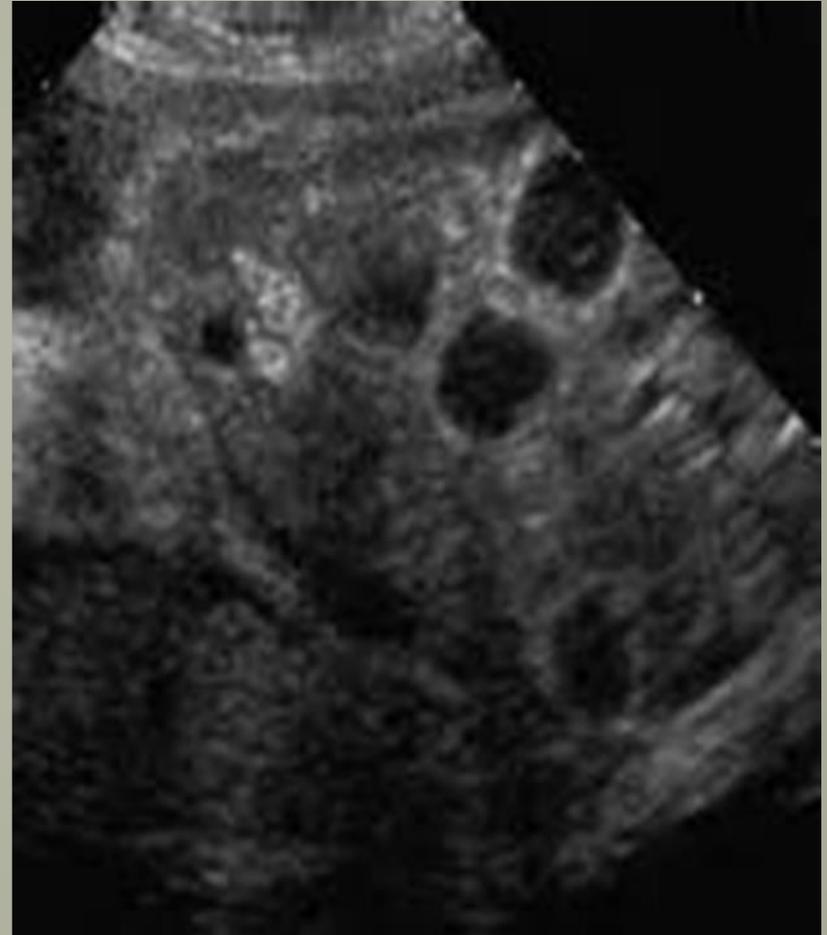
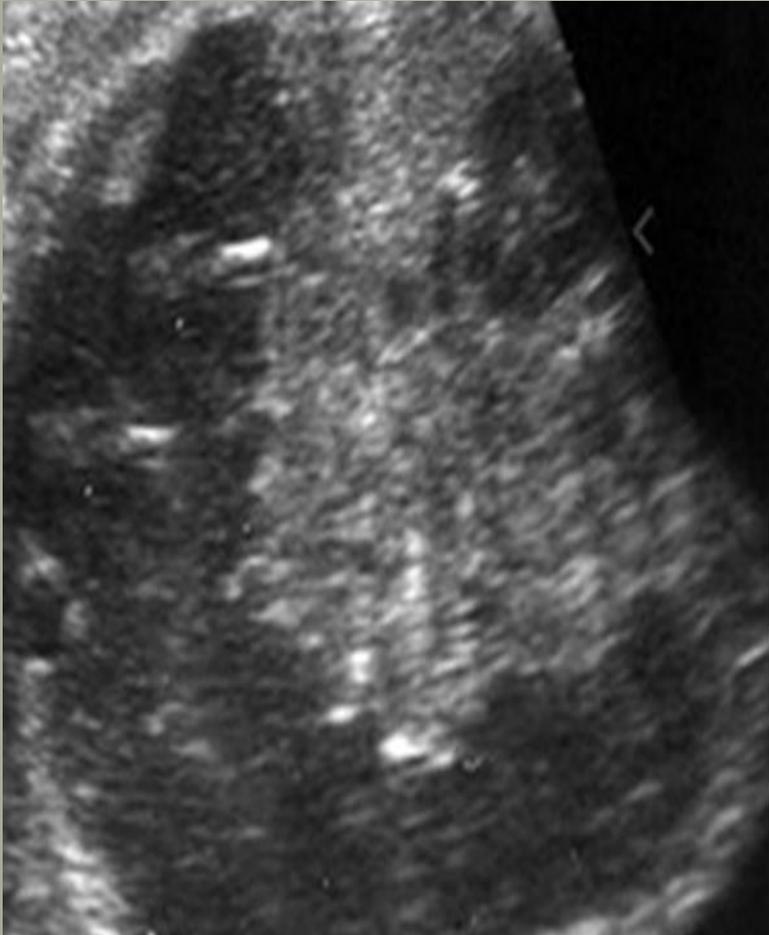
- ◎ **Other conditions associated with echogenic small bowel**
 - **Trisomy 21**
- ◎ **Meconium peritonitis may occur secondary to perforation of obstructed bowel**

Meconium ileus and peritonitis



Bowel dilation (*b*)

Meconium Ileus



Other Small-Bowel Obstructions

- **Chloridorrhea**

- **Life-threatening diarrhea in the newborn**

- **Megacystis-microcolon intestinal hypoperistalsis syndrome**

- **Absence of peristalsis**
- **Bladder dilation and hydronephrosis in predominantly female fetuses**

Anorectal Atresia

- ◉ **Complex disorder of the bowel and genitourinary tract**
- ◉ **Imperforate anus**
 - **Occurs when a membrane covers the anus**
 - **Prohibits expulsion of meconium**
- ◉ **May be diagnosed by observing**
 - **Dilated colon**
 - **Calcified meconium**

Anorectal Atresia

- **Amniotic fluid is typically normal or may be decreased when there are associated renal problems**
- **May present as part of the VACTERL association or in caudal regression**
- **Prognosis is poor because of associated anomalies**
- **Incontinence of both bowel and bladder is common in the infant**

Hirschsprung's Disease

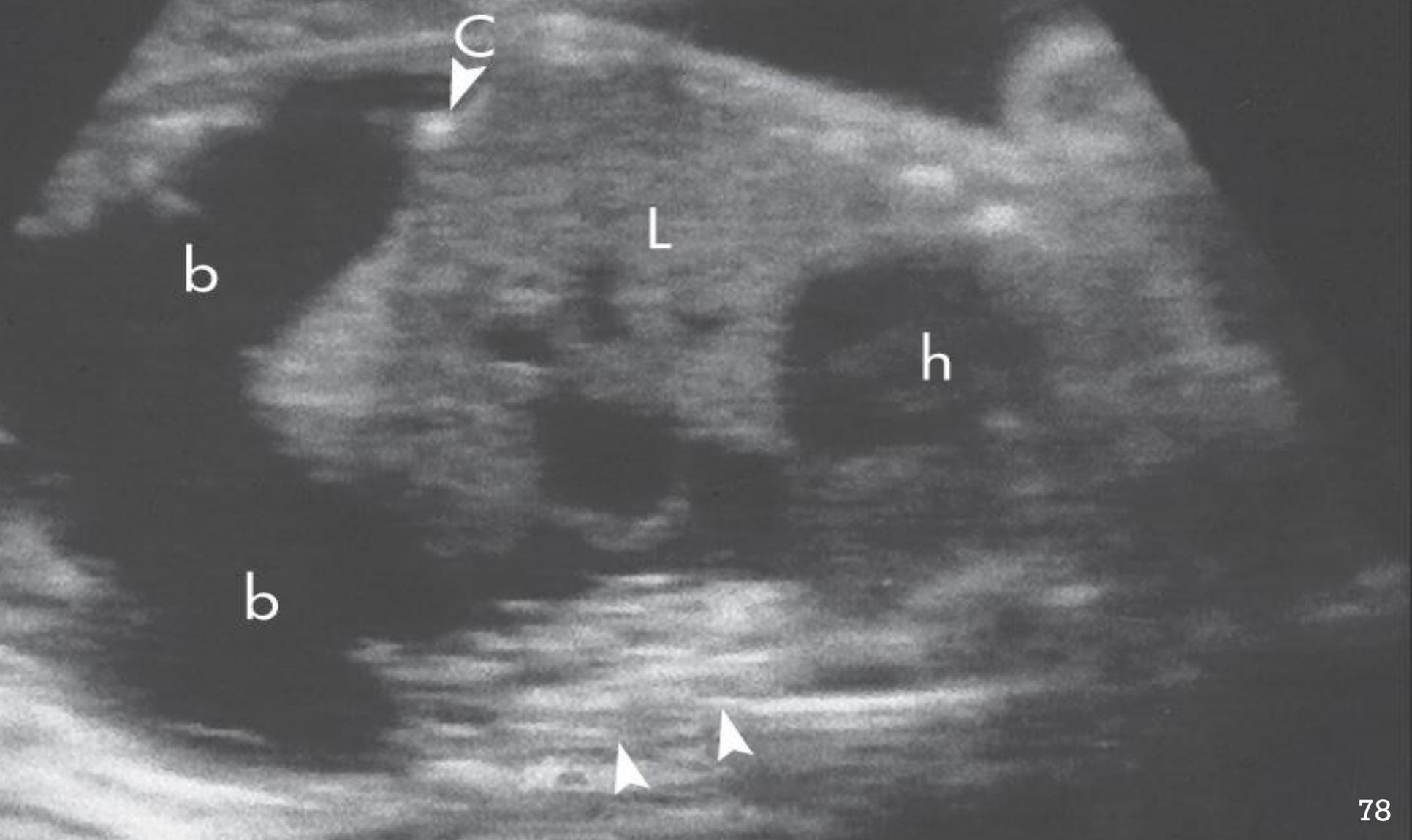
○ Megacolon

- **Congenital disorder in which there is abnormal stimulation of nerves of the large intestine**
- **Condition is difficult to differentiate prenatally**
- **May be suspected when dilated bowel loops are observed**

Meconium Peritonitis

- **Condition may arise secondary to in utero bowel perforation**
- **Ascitic fluid also may be echogenic**
- **Polyhydramnios is present in 65% of cases**
- **Complication may result in formation of a meconium pseudocyst**
 - **Inflammatory reaction seals the perforation**

Meconium peritonitis secondary to bowel obstruction shown with an irregular appearance of the bowel (*b*)
Clumping of bowel observed (*arrows*)



Hyperechoic Bowel

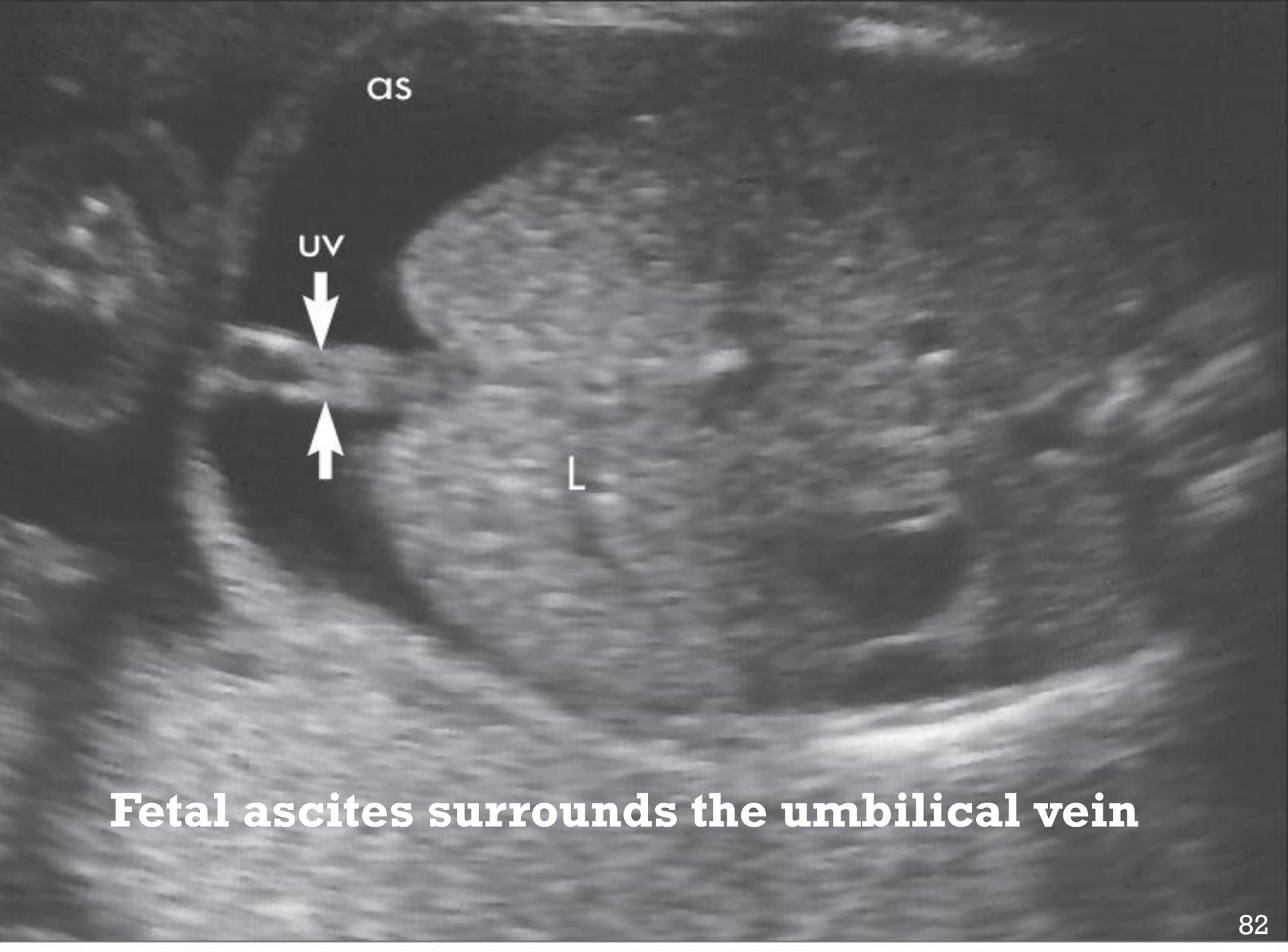
- **Is a subjective impression of an unusually echogenic bowel**
 - **Typically seen during the second trimester**
- **Causes may be**
 - **Decreased water content**
 - **May be secondary to hypoperistalsis**
 - **Given that fluid is normally resorbed by the small bowel**
 - **Alterations of meconium, or both**
- **Significance of hyperechoic bowel varies**
 - **With its location in the small bowel or colon**
 - **Menstrual age**
 - **Degree of echogenicity**

Hyperechoic Bowel

- **Three classifications of determining the degree**
 - **Grade 1:**
 - **Mildly echogenic and typically diffuse**
 - **Grade 2:**
 - **Moderately echogenic and typically focal**
 - **Grade 3:**
 - **Very echogenic, similar to that of bone structures**

Ascites

- **True ascites is always abnormal**
- **Fluid collects between the two leaves of unfused omentum**
 - **Results in a cyst-like appearance in the abdomen**
- **Usually outlines the falciform ligament and umbilical vein**
- **When associated with hydrops fetalis, pleural effusions, and pericardial effusion**
 - **Integumentary edema often observed**



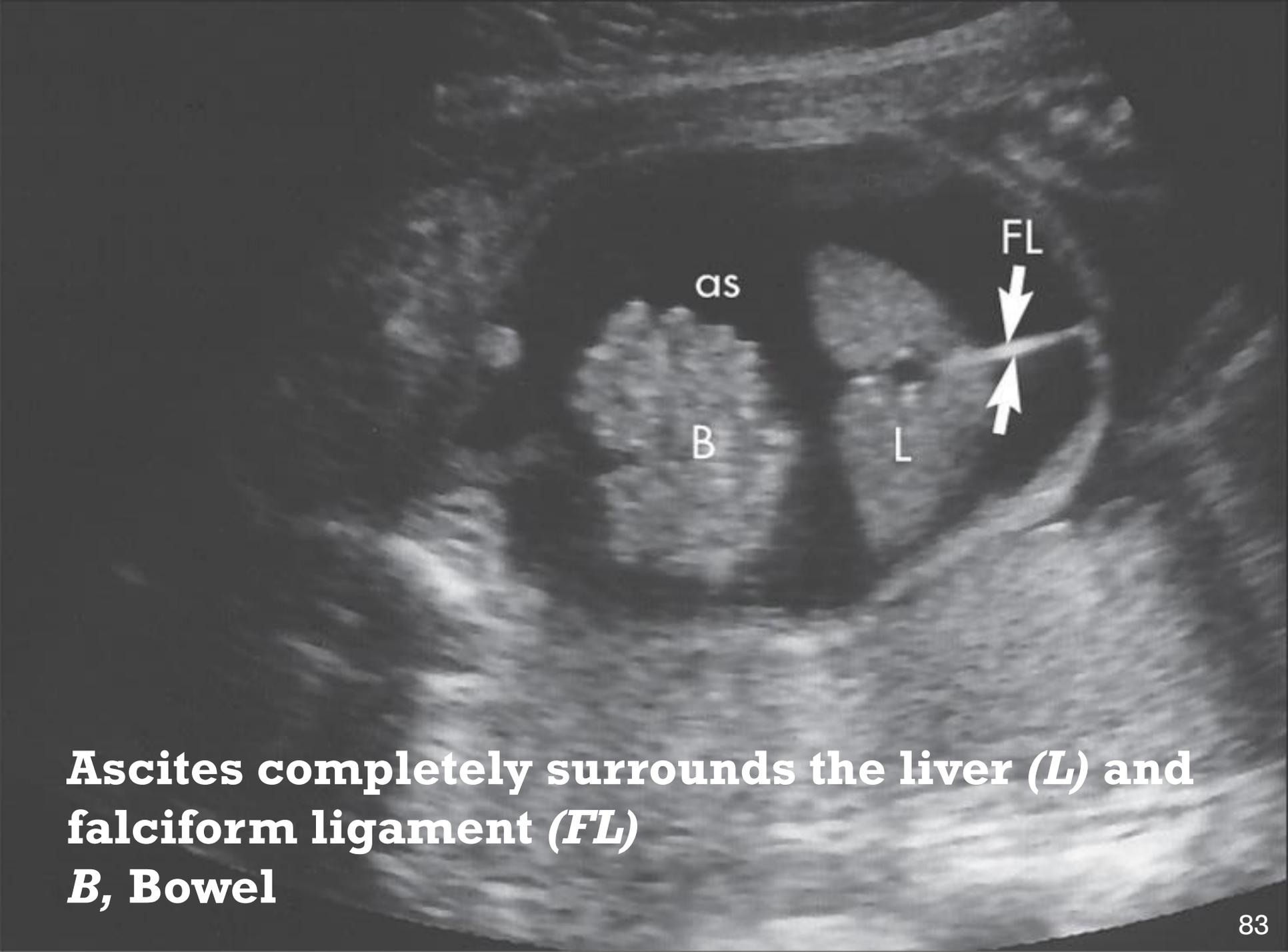
as

UV



L

Fetal ascites surrounds the umbilical vein



**Ascites completely surrounds the liver (*L*) and falciform ligament (*FL*)
B, Bowel**



Miscellaneous Cystic Masses of the Abdomen

Important to Determine

- ① **Precise location of the mass**
- ① **Size of the mass**
- ① **Resultant compression of other organ systems**
 - **Hydronephrosis**
 - **Hydroureter**
 - **Fetal hydrops**