

Neonatal & Pediatric Abdomen

Chapter 25



Objectives:

- Recognize different pediatric stages and best techniques to maximize patient cooperation
- Identify pediatric gastrointestinal pathologies that may require emergent surgery
- Discuss sonographic techniques used to detect different pediatric GI pathologies
- Describe symptoms related to pediatric GI pathologies
- Analyze sonographic images of the various pathologies

Pediatric Scanning Considerations:

- Table 25.1, 25.2
- Always use warm gel
- Keep infant warm and secure
 - ✓ Wrap blankets around infant
 - ✓ Use as little gel as possible
 - ✓ Remove gel as soon as possible; it gets cold quickly
- Have them bring comfort items into exam room

Pediatric Scanning Considerations (cont'd):

- Explain examination to parents and child
- Use age- appropriate terms
- Soft voice
- Eye contact
- Concentrate on child
- Begin exam in well-lit room
- Transducers
 - use highest frequency transducer for area imaged
 - linear, curved array, or sector

Pediatric Scanning Considerations (cont'd):

- Take breaks:
 - ✓ Give child a rest
 - ✓ Let mother hold child until calm
 - ✓ Feasible to allow child to lie next to mother on stretcher to continue exam
- Older child:
 - ✓ Explain procedure before child undresses
 - ✓ Have mother and child touch transducer and gel and be ready to “watch the movies”

Pediatric Exam Prep:

Abdominal Ultrasound:

- 0-2 yr: NPO 4 hr
- 3-5 yr: NPO 5 hr
- 6+ yr: NPO 6 hr

Pelvic Ultrasound:

- 0-9 yr: Plenty of juice or water 30 minutes before examination and no voiding
- 10+ yr: 32 oz water 1 hour before examination. No voiding

GI Pathology

COMMON SURGICAL CONDITIONS:

- The pediatric patient may appear in the general ultrasound lab on an emergent basis for extreme abdominal pain or vomiting with three common surgical conditions:
 - *Appendicitis*
 - *Intussusception*
 - *Hypertrophic pyloric stenosis*

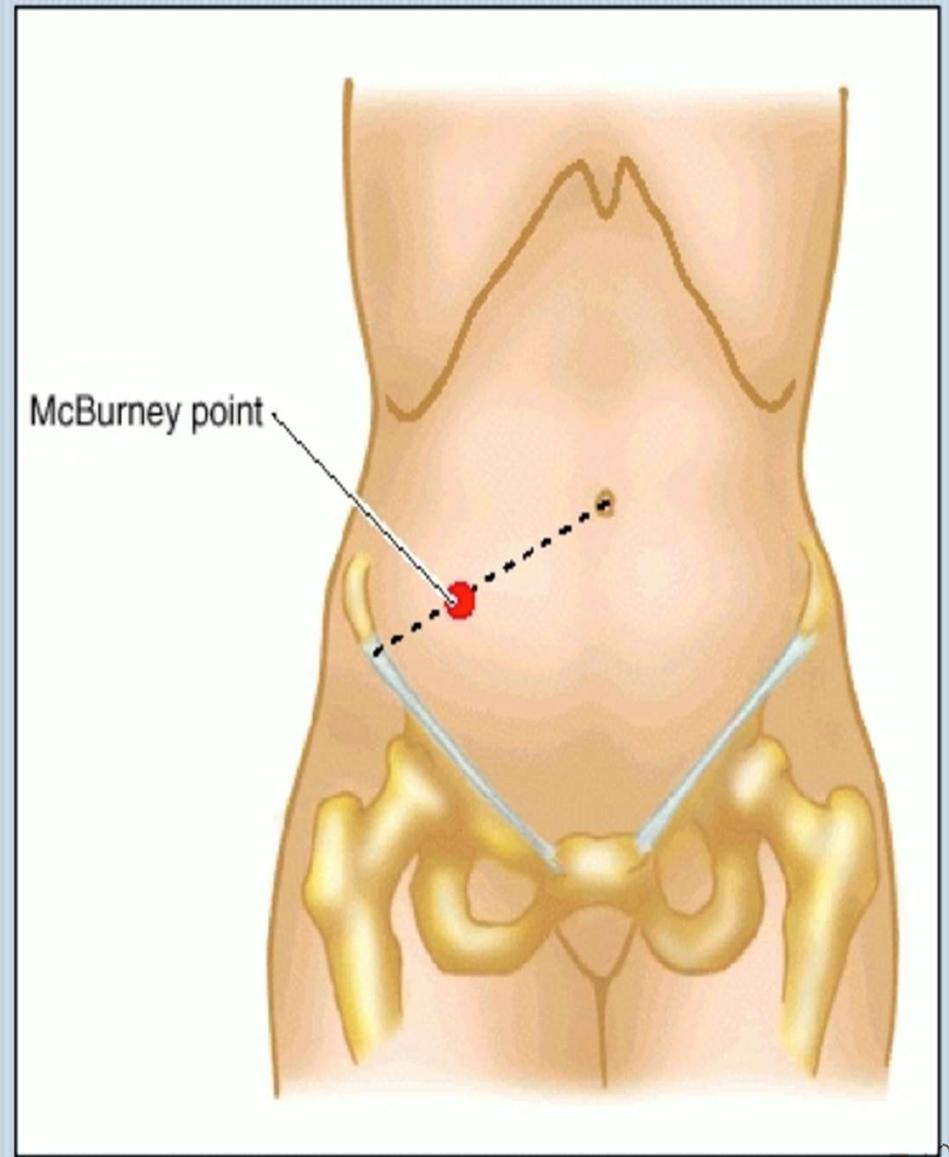
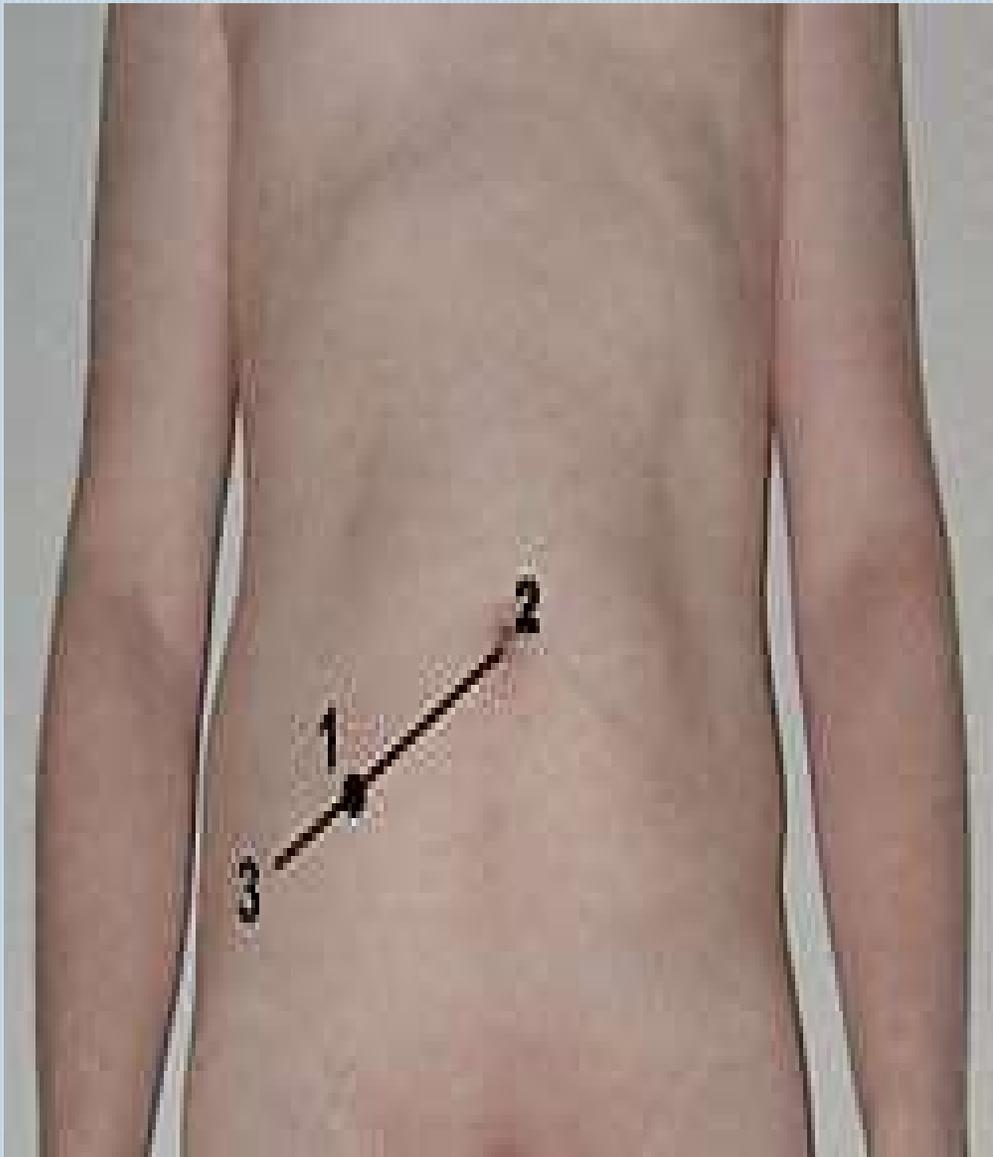
Appendicitis

- ❖ Most common cause of emergent surgical abdominal pain in children
- ❖ Mostly occurs in patients ages 5-15 years old, but may occur as young as three months old (although rare under the age of two)
- ❖ Male (1.7:1) prevalence

Appendicitis (cont'd)

- Occurs when the appendiceal lumen becomes obstructed and subsequently infected
- In infants and young children, the progression of acute appendicitis to perforation is more rapid than in older children and adults, sometimes occurring within 6 to 12 hours
- Perforation of the appendix is a serious complication of appendicitis, along with peritonitis, abscess formation, and sepsis
- Right lower quadrant pain and vomiting are a common clinical presentation

McBurney's Point



Sonographic Technique

- Gradual graded compression is slowly applied over the area of the appendix in the right flank and right lower quadrant with a linear array transducer.
- In infants and young children- frequencies of 12-17 MHz may be used, older children 5-9 MHz
- Appendix is usually seen anterior and medial to the psoas muscle and lateral to the iliac vessels

Sonographic Technique (cont'd)

- Ask the patient to point to the place of pain with one finger
- Helpful to follow the ascending colon and cecum inferiorly to the ileocecal junction, where the appendix comes off just posteromedial (inferior) to this valve
- Normal appendix appears as a blind-ending, long, tubular structure in the longitudinal plane and as a bull's-eye in the transverse plane

Sonographic Technique (cont'd)

- Nonvisualization may result from any of the following:
 - (1) overlying bowel
 - (2) retrocecal position or deep pelvic position of the appendix
 - (3) overdistention or nondistention of the urinary bladder, which alters the position of the appendix and overlying bowel
 - (4) lack of sonographer experience

How to Scan...

- <https://youtu.be/PfxxVXsQsfY?si=-XJa0lx2xl5rcl4n>

Sonographic Findings

- Peristalsis is not seen in the appendix, allowing differentiation of the normal appendix and adjacent small bowel, which is similar in appearance
- Appendix may be tortuous and therefore difficult to visualize in its entirety
- Walls not thickened- maximal mural thickness should measure less than 1.7 mm
- Normal appendix compresses easily and the lumen may be empty, or filled with gas or fecal material

Sonographic Findings (cont'd)

- Appendix is measured from outer-to-outer wall, using the anterior-posterior (AP) maximum outer diameter (MOD).
- Measurements are best made in the plane with the most well defined wall, as acute appendicitis may present with a less defined or ragged wall
- $MOD \geq 7$ mm with compression is consistent with appendicitis both in children and adults
- MOD between 6-7 mm is indeterminate and often established by each institution based on their outcomes

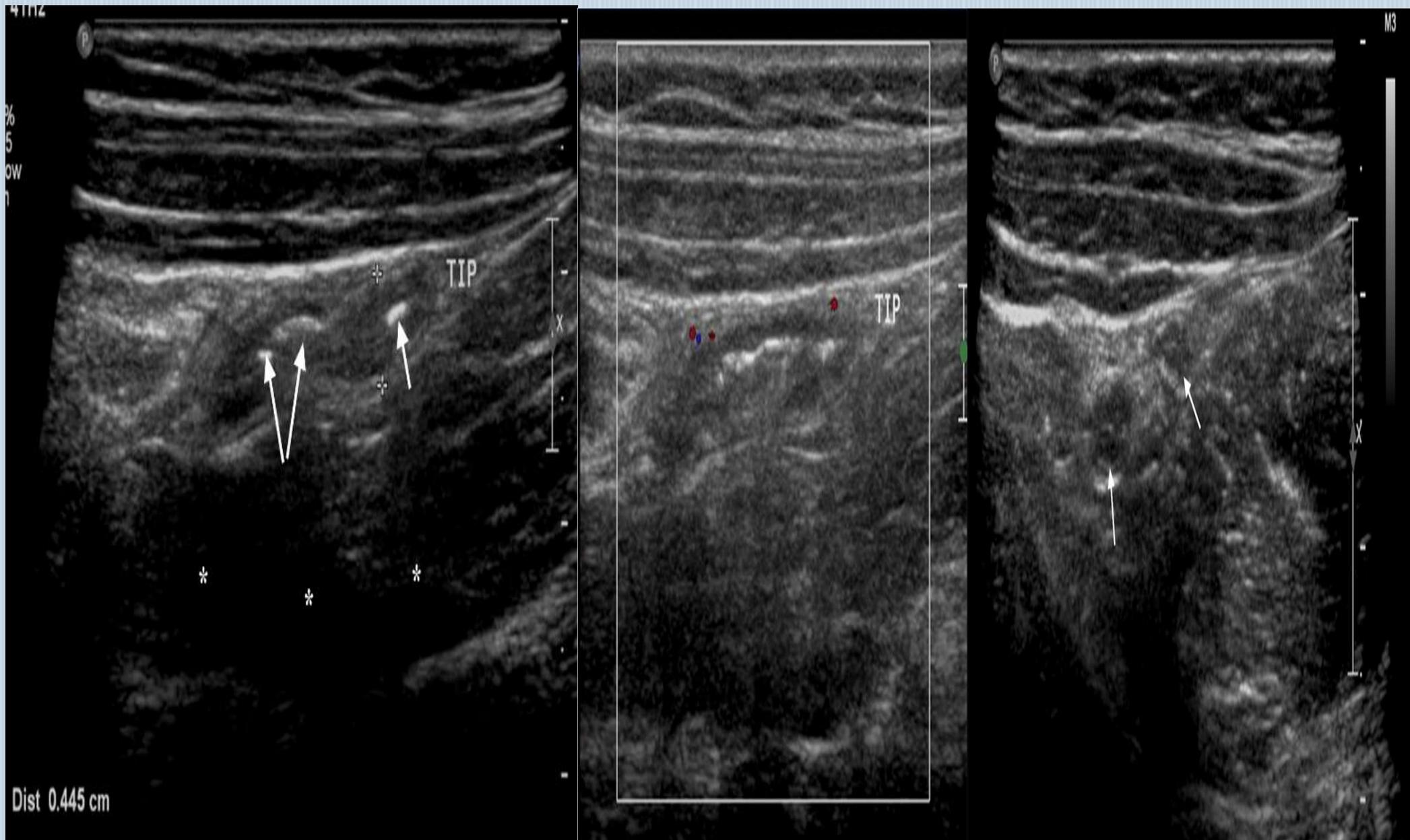
Sonographic Findings (cont'd):

- May include free peritoneal fluid or a loculated fluid collection in the lower abdomen
- Mesenteric lymph nodes are another non-specific secondary finding, and sonographers should report size, number, location and hyperemia
- Confirmation of an appendicolith in a symptomatic patient is virtually diagnostic

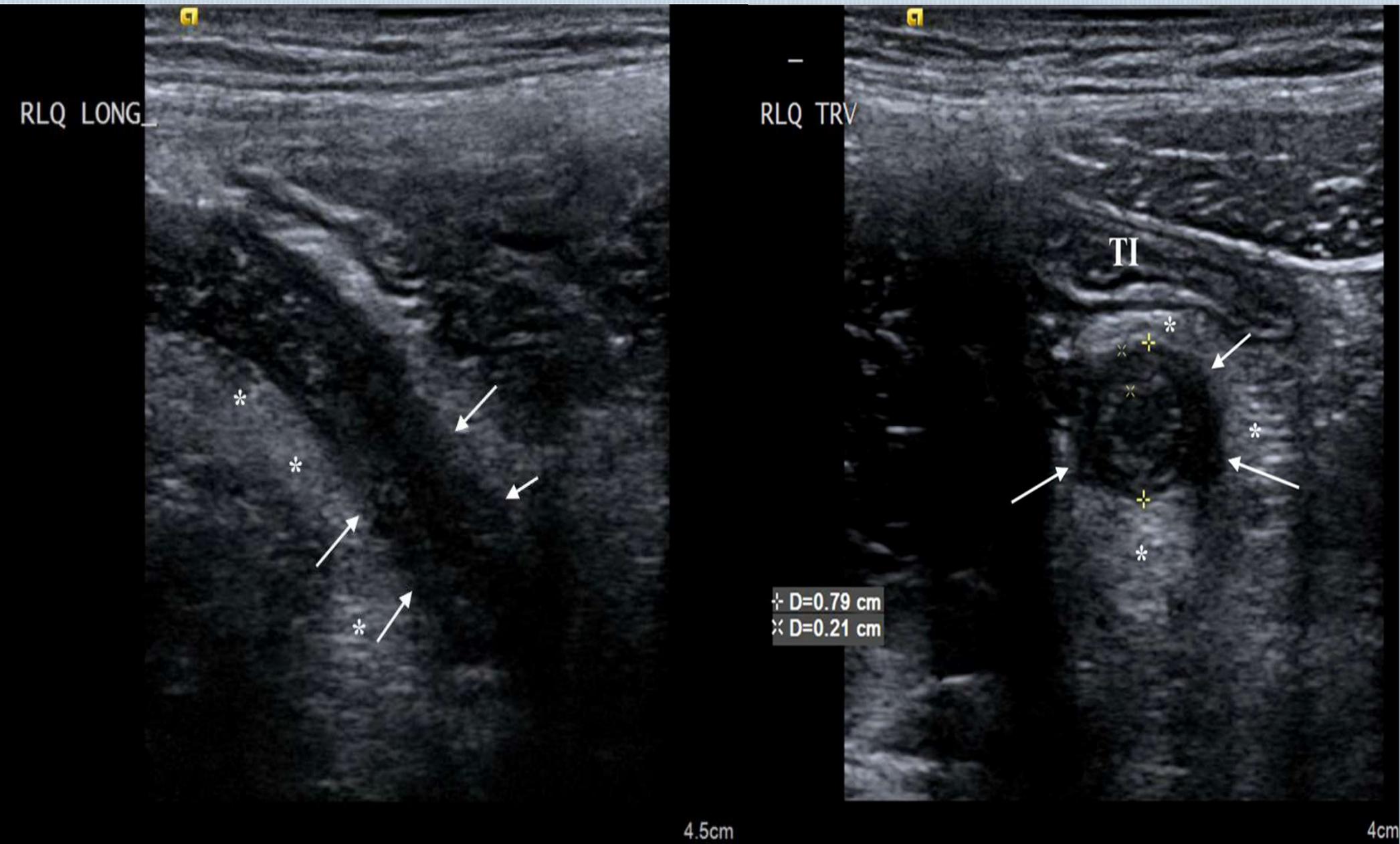
Normal Appendix

- <https://youtu.be/VO51vgSEXuE>
- https://www.youtube.com/watch?v=am_m4J9bryM&pp=ygUdIGh0dHBzOi8veW91dHUuYmUvYW1fbTRKOWJyeU0%3D

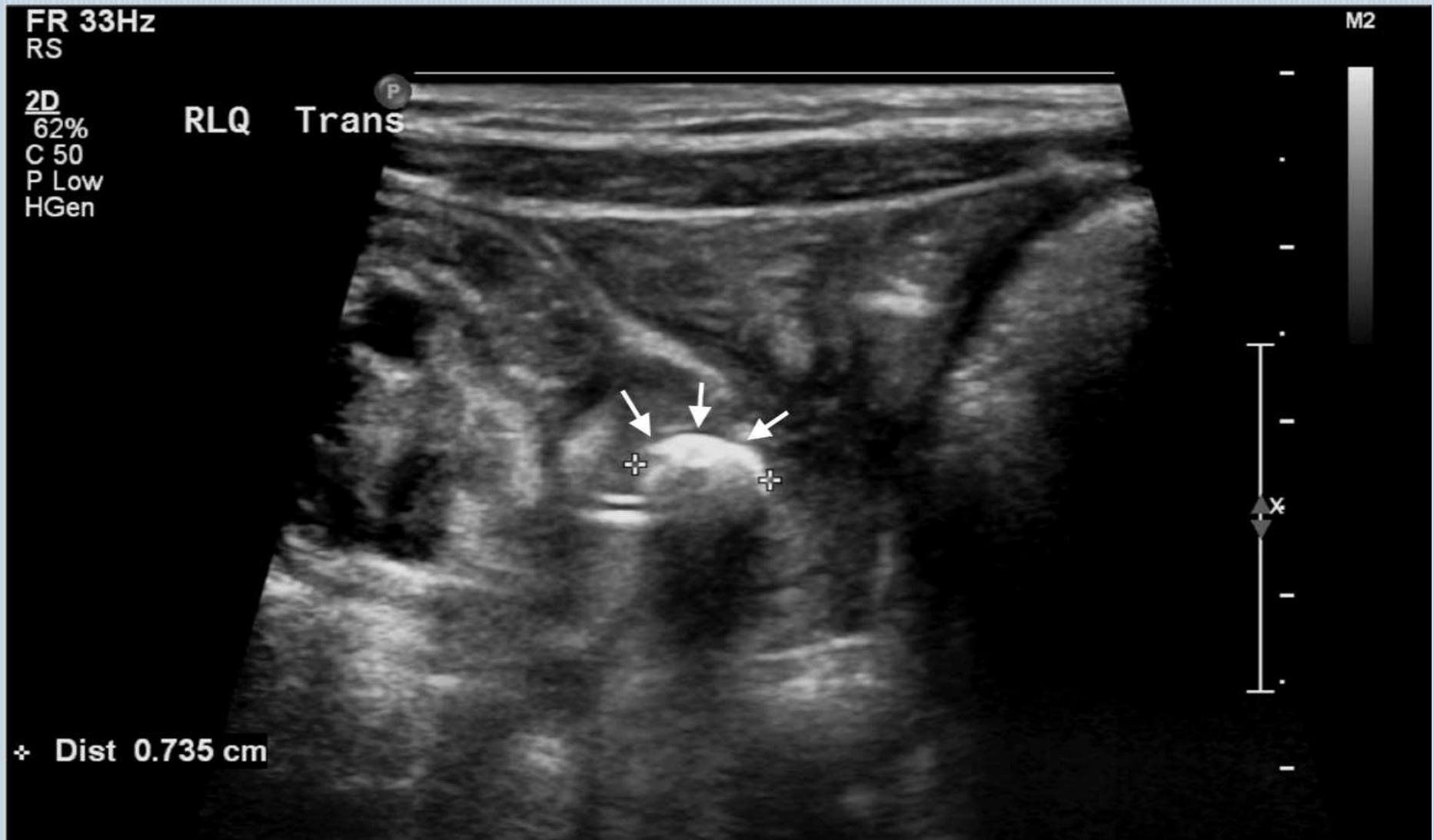
Normal Appendix



Appendicitis



Appendicitis/Appendicolith



Appendicitis/Appendicolith

- <https://youtu.be/l2aF9OYlXto>
- <https://youtu.be/NasAgUkEuDw?si=9ZFW2nrQlalzSroW>

Intussusception

- Most common acute abdominal disorder in early childhood
- Occurs when bowel prolapses into more distal bowel and is propelled in antegrade fashion
- Telescoping of bowel causes obstruction

Intussusception

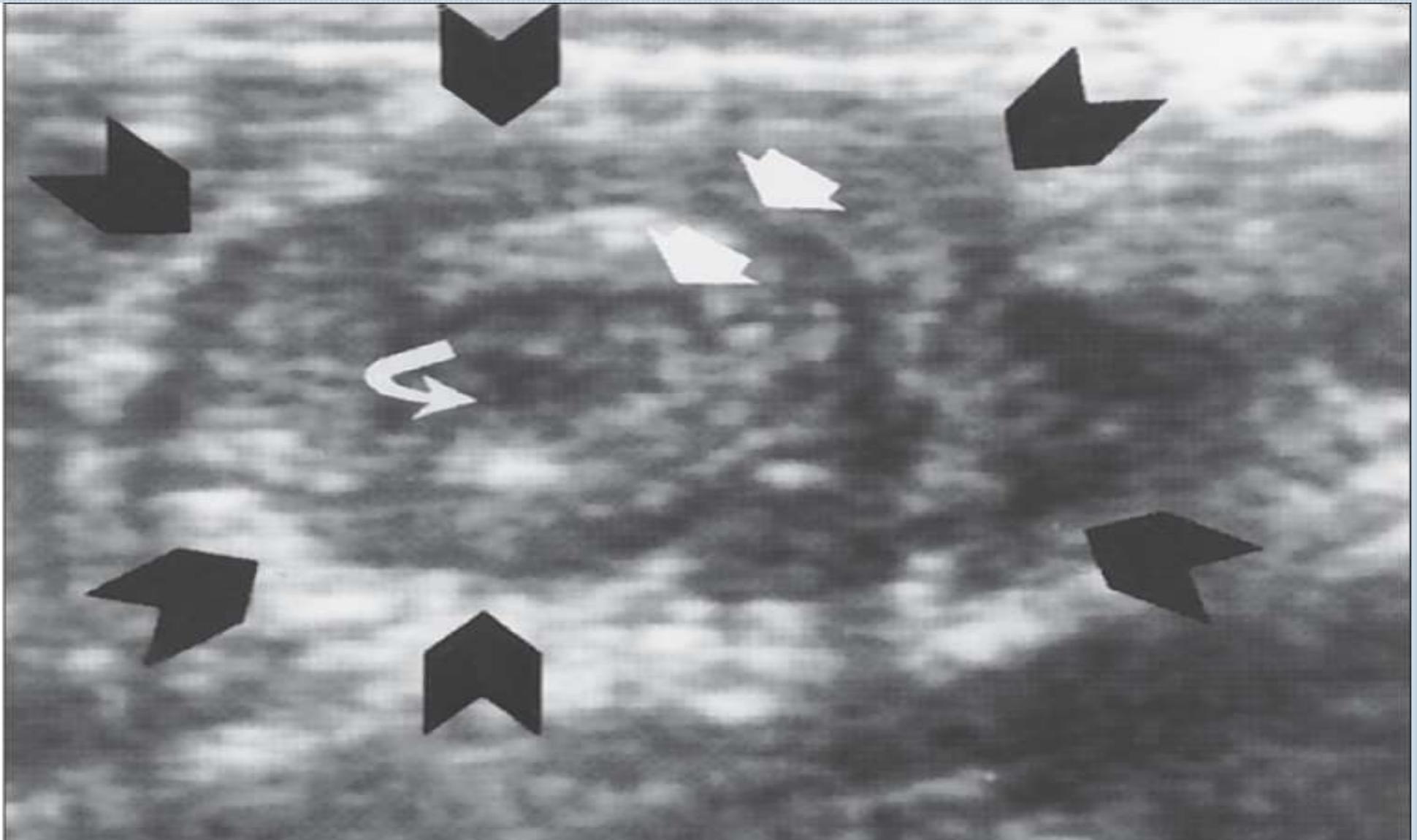
- 90% of cases includes the prolapse of the ileum into the cecum or beyond producing an ileocolic intussusception
 - usually seen in children between the ages of 6 months old and 2 years old (males 2:1 > females)
 - may present with colicky abdominal pain, vomiting, and bloody (currant jelly) stools
 - abdominal distention or a mass may also be palpable in up to 50% of patients

Intussusception

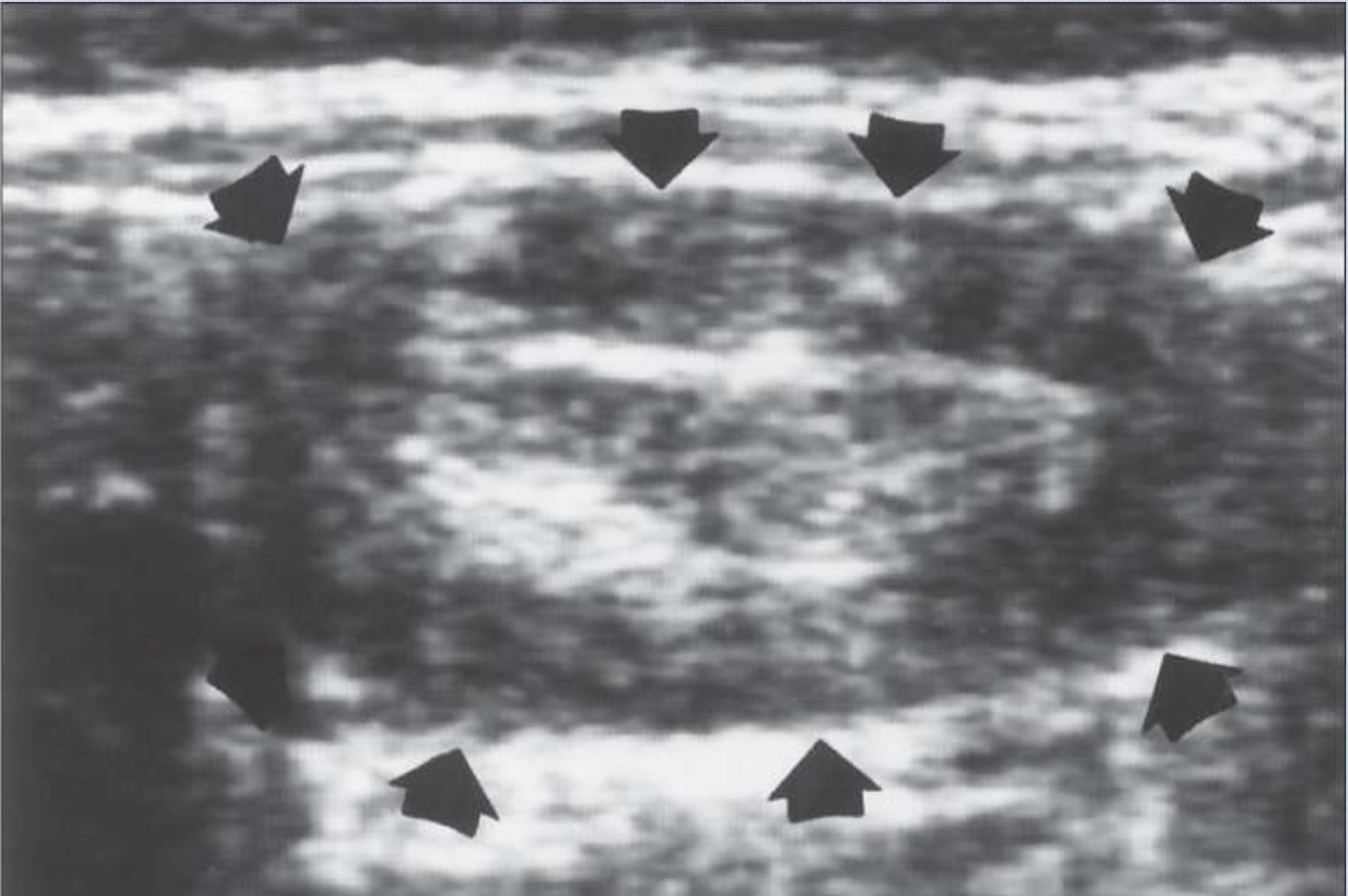
- Sonographic Technique:
 - The patient is examined in the supine position
 - A brief survey of the entire abdomen is performed, dividing the abdomen into four quadrants, followed by an examination focusing on the bowel using a 5 to 12 MHz linear or curved array transducer
 - The bowel is followed, often starting at the cecum in the RLQ

Sonographic Appearance

- Short axis
 - Alternating hypoechoic and hyperechoic rings surrounding an echogenic center
 - *Doughnut or target sign
- Long axis
 - Hypoechoic layers on each side of echogenic center
 - *Pseudokidney or sandwich appearance
- Color Doppler may help determine success of an air reduction enema
 - If good color flow to all areas of telescoping bowel, chances are better for a reduction



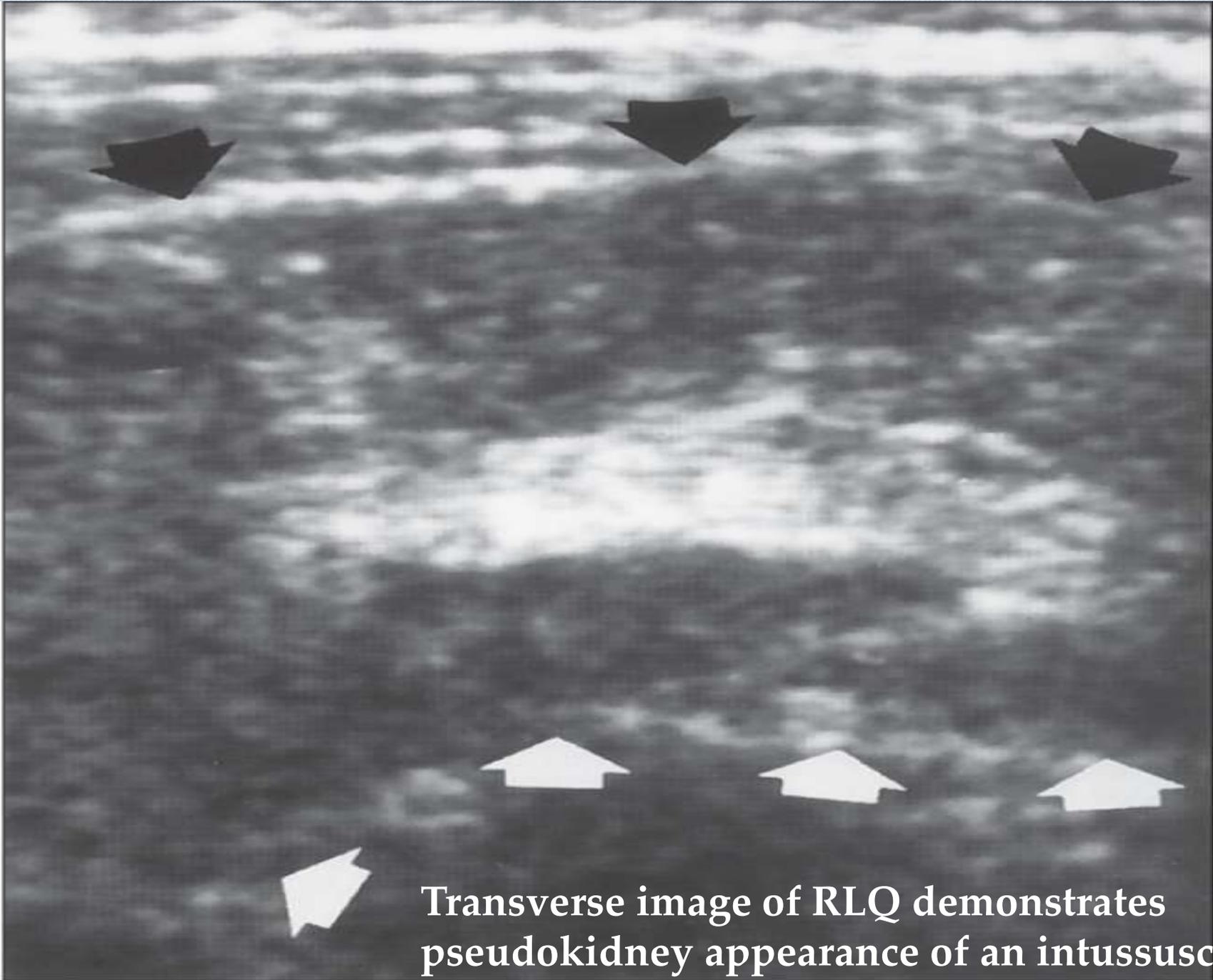
A Transverse image of an intussusception (*arrowheads*) showing a target sign. There are several circumferential layers of increased and decreased echogenicity (*arrows*) because of telescoping bowel. Lumen



A Intussusception (*arrows*) is identified. Target sign is present, but, instead of being round, it is more C-shaped because bowel loop is coiled on itself

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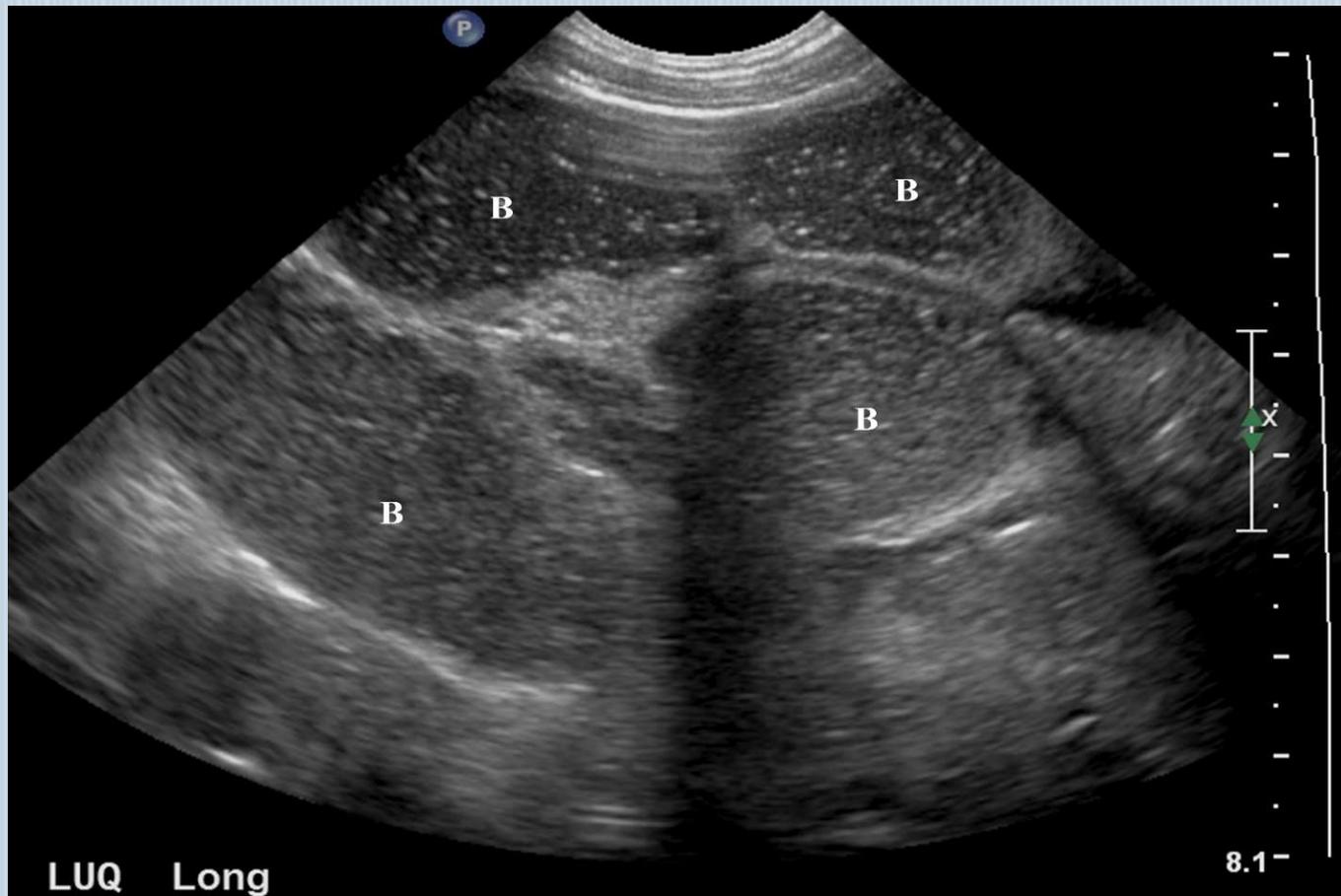
B



Transverse image of RLQ demonstrates pseudokidney appearance of an intussusception (arrows)

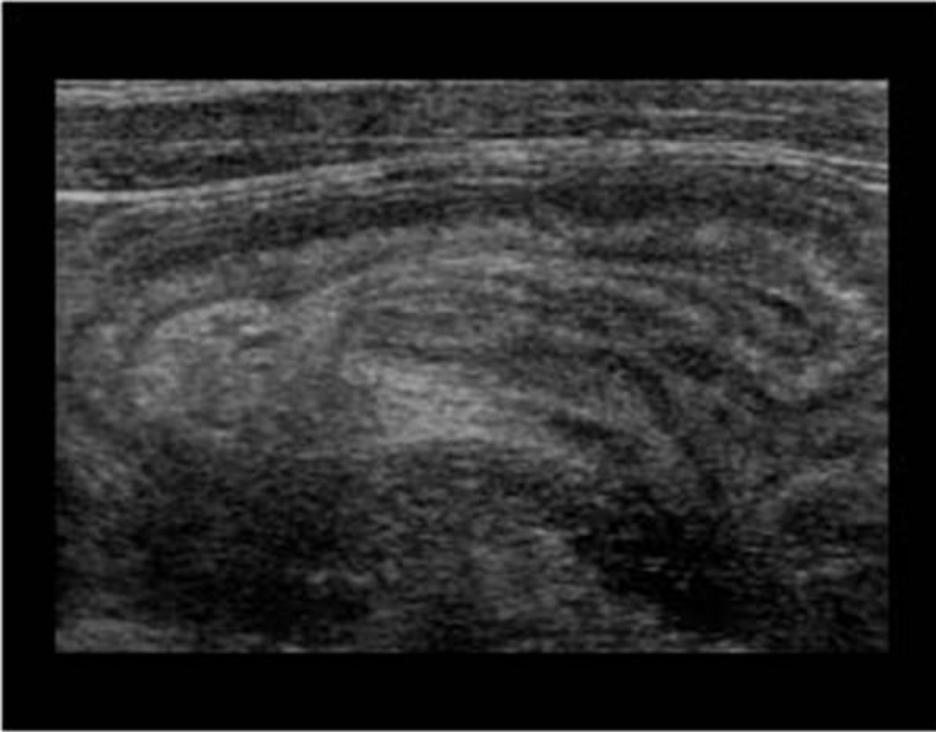
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Dilated Loops of Bowel



Intussusception Sonographic Images

- Long



Trans



Sonographic Appearance (cont'd)

- Sonographic Findings:
 - The sonolucent ring is believed to represent the edematous infolded loop of the intussusceptum, whereas the echogenic central area represents its compressed mucosa
 - Other concentric rings are present resulting from visualization of additional bowel wall layers within the intussusception

Intussusception

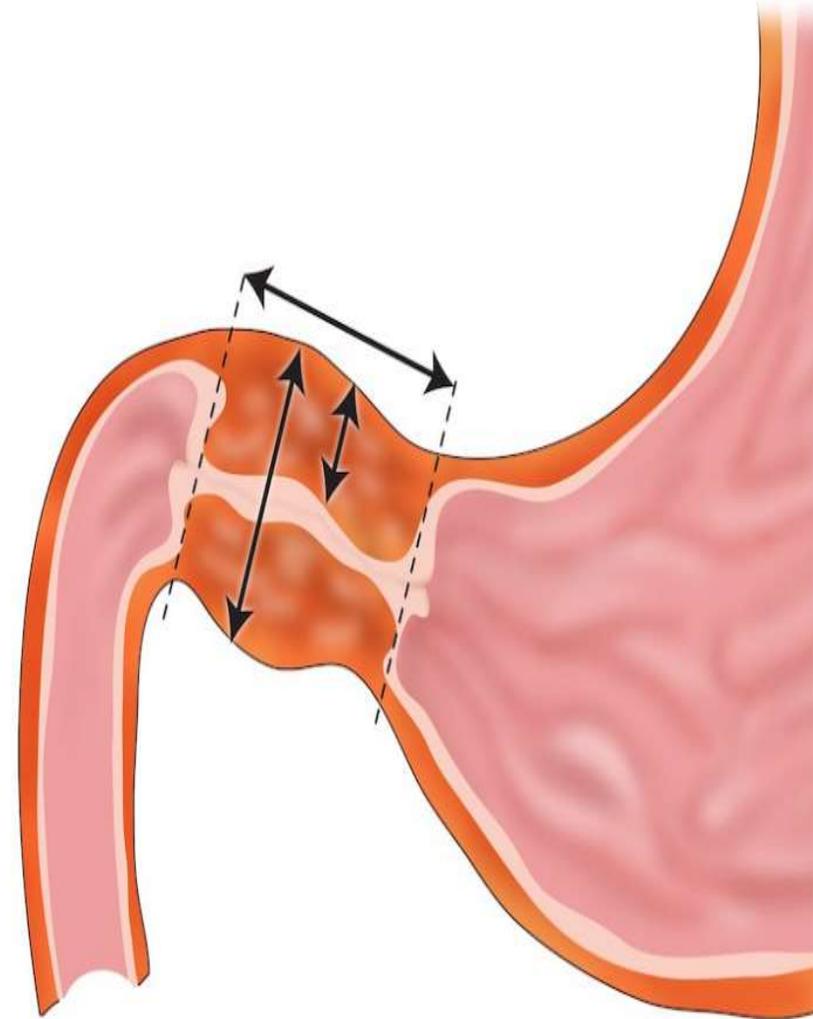
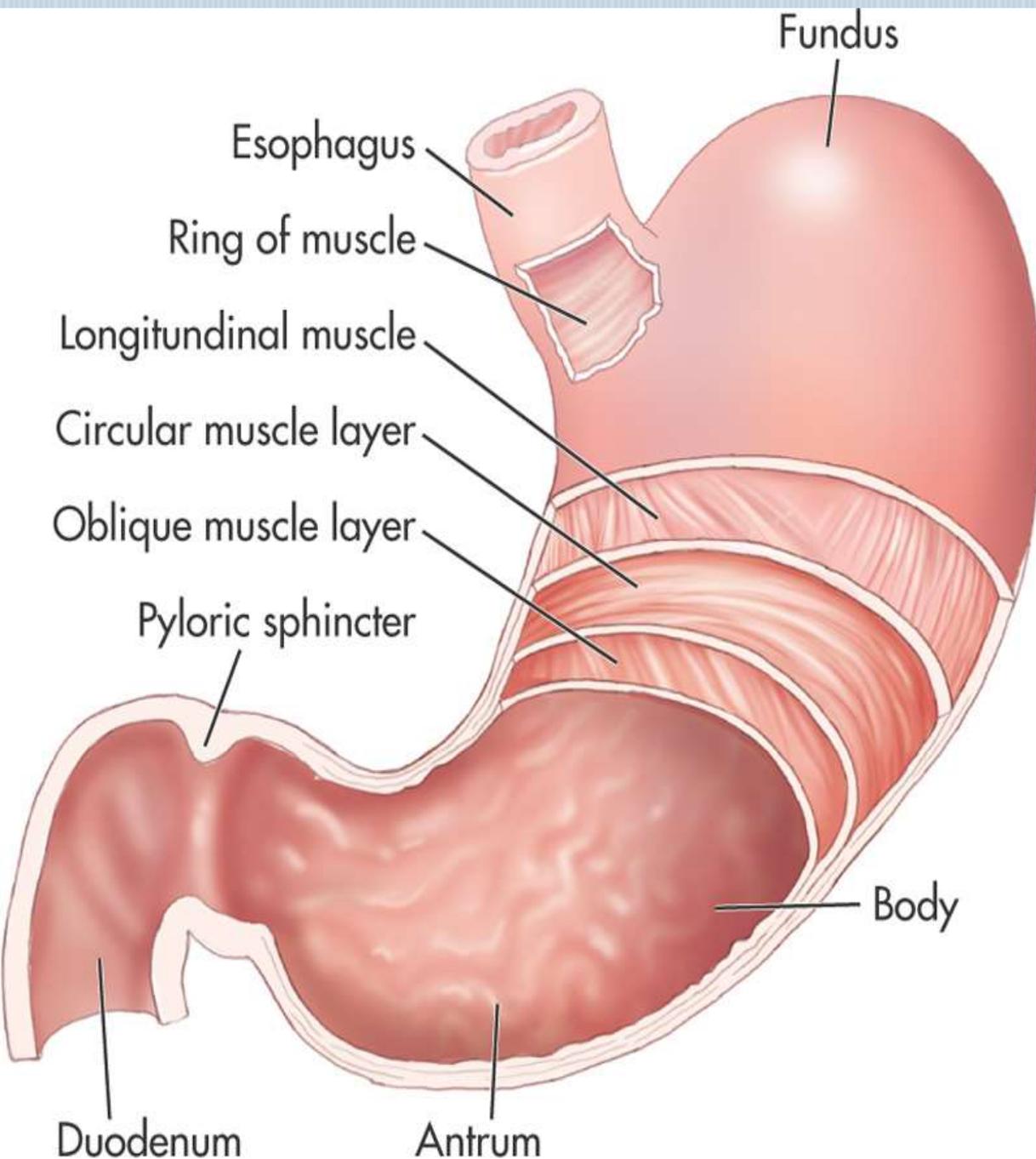
- https://youtu.be/rRO_b7yZMsU?si=2-W57XgiboyVHsHv

Intussusception



Hypertrophic Pyloric Stenosis (HPS)

- Pyloric canal located between the stomach and duodenum
- Pyloric muscle can become hypertrophied, resulting in significantly delayed gastric emptying
- Hypertrophy of the circular muscle of the pylorus is an acquired condition that narrows the pyloric canal
- Pyloric canal itself is not intrinsically stenotic or narrowed but functions as if it were due to the abnormally thickened surrounding muscle



Normal values *

Length: <15mm

Single muscle thickness: <3mm

Pyloric width: <7mm

HPS (cont'd)

- Presents most commonly in male infants
 - between 3 and 12 weeks (peak @ 4 wks)

*Bile-free emesis in an otherwise healthy infant is the most frequent clinical presentation

- projectile vomiting

- As pyloric muscle thickens and elongates, stomach outlet obstruction increases and vomiting is more constant and projectile

HPS (cont'd)

- Dehydration and weight loss may occur
- Peristaltic waves and reverse peristaltic waves crossing upper abdomen may be observed during or after feeding
- Stomach attempts to force its contents through the abnormal canal resulting in projectile vomiting

*Sonography is the imaging method of choice

Contrast Radiography

- Upper GI exam necessary to assess for other potential causes of vomiting such as:
 - Gastrointestinal reflux
 - Antral web
 - Pylorospasm
 - Hiatal hernia
 - Malrotation of bowel

Sonographic Technique

- Preliminary survey of abdomen is performed first to exclude abnormalities
 - Hydronephrosis
 - Adrenal hemorrhage
- 5- to 12- MHz linear array transducer

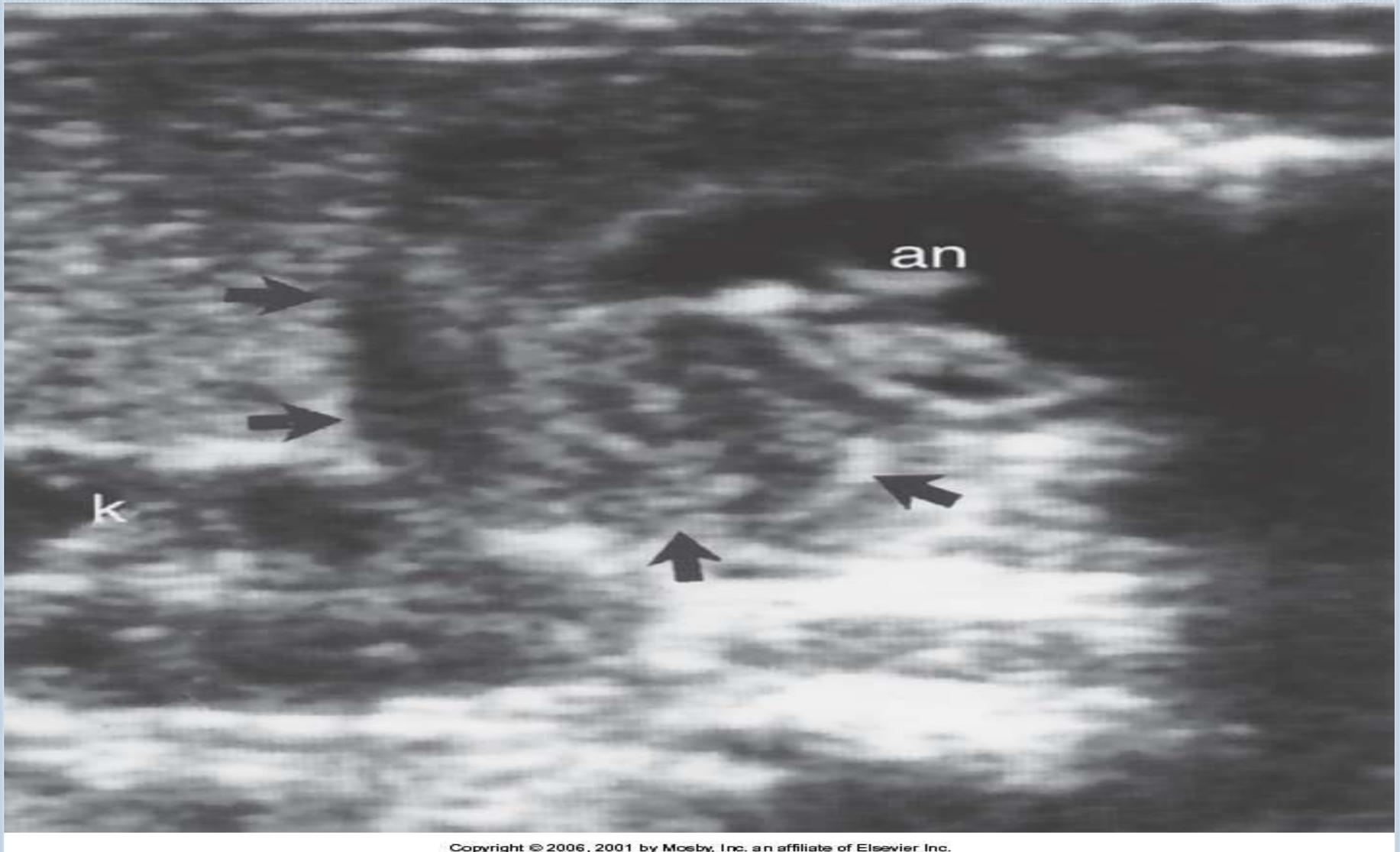
Sonographic Technique (cont'd)

Longitudinal images

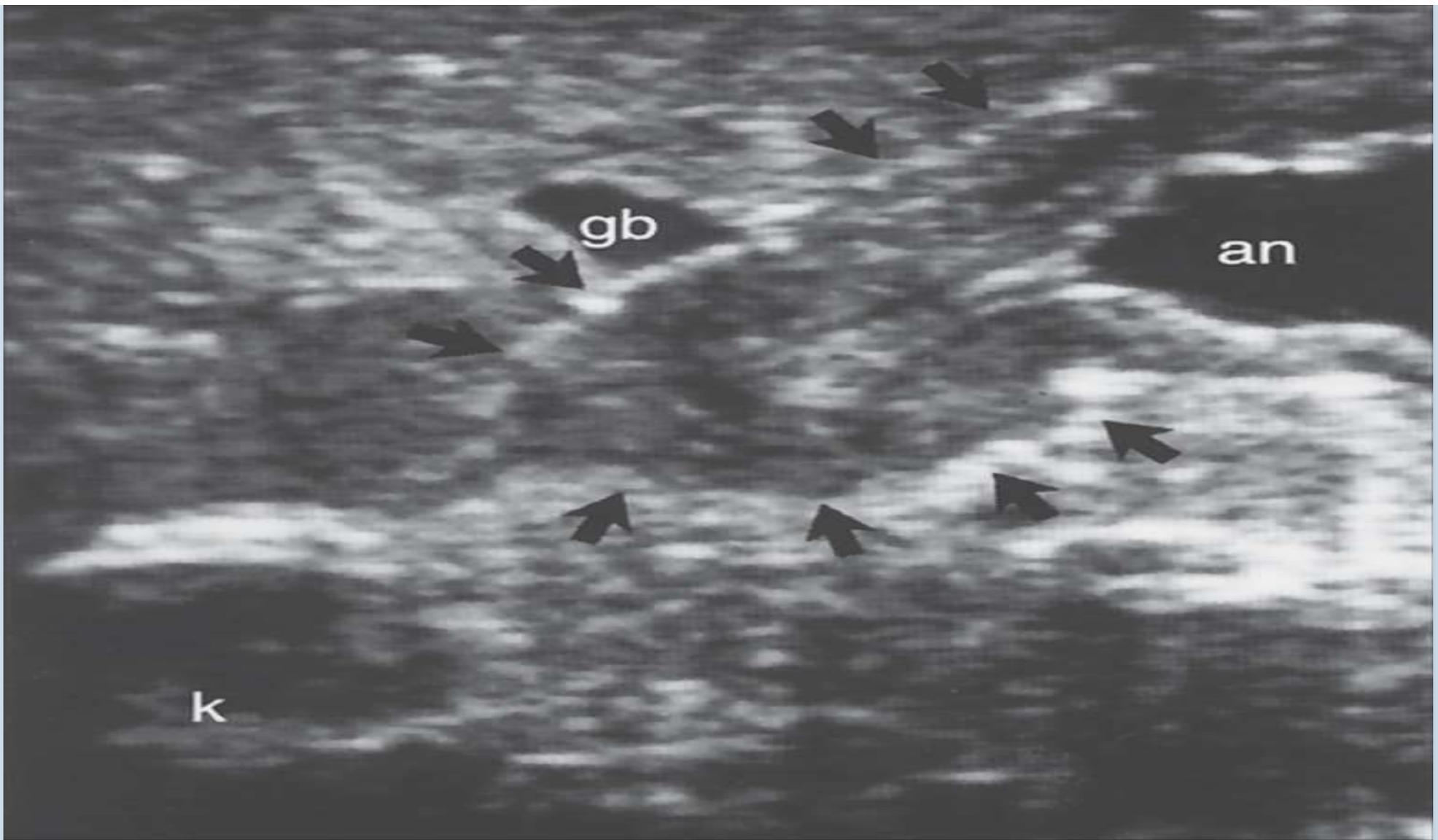
- Place transducer transversely across RUQ just below xiphoid process
- Rotated obliquely until pyloric muscle is visualized in its long axis

Sonographic Technique (cont'd)

- If stomach is empty and HPS is not apparent, oral feeding is given
 - Glucose water
 - Pedialyte
- Overly distended stomach can displace pyloric muscle posteriorly, making visualization virtually impossible



Fluid-distended antrum (*an*) has pushed elongated pyloric muscle (*arrows*) posteriorly, not allowing accurate measurement of length of pyloric canal

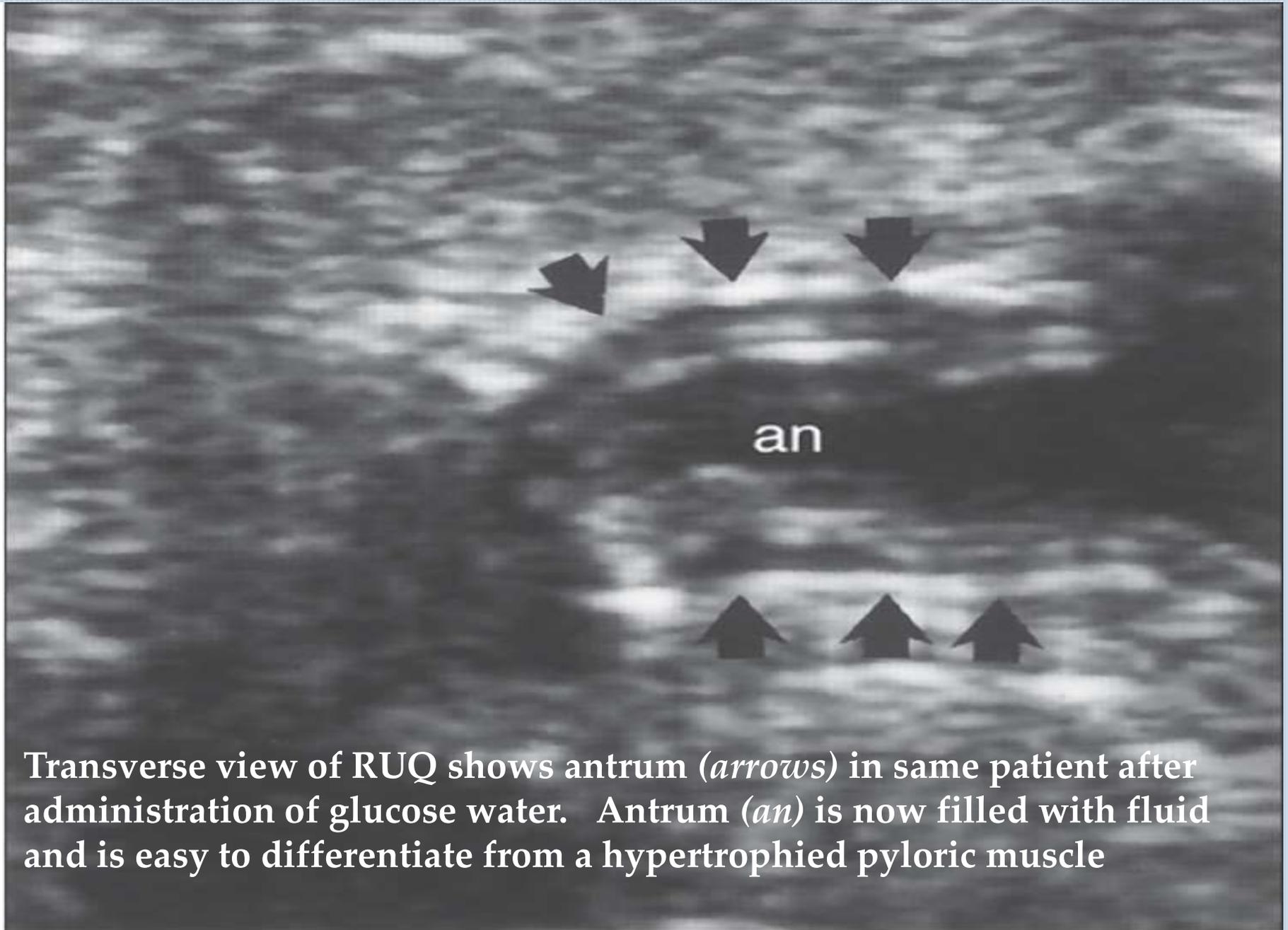


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Transverse image of RUQ using liver as a window in a 5-week-old boy with hypertrophic pyloric stenosis shows a longitudinal view of an elongated thickened pyloric muscle (*arrows*). Antrum (*an*) is filled with fluid. The gallbladder (*gb*) is anterior to the pyloric muscle, whereas the right kidney (*k*) is posterior and lateral



A Antrum (*arrows*) is collapsed and contains a linear echogenic centrum representing interface between lumen and mucosa



Transverse view of RUQ shows antrum (*arrows*) in same patient after administration of glucose water. Antrum (*an*) is now filled with fluid and is easy to differentiate from a hypertrophied pyloric muscle

B

Sonographic Technique (cont'd)

Transverse images

- Obtained from right coronal plane
- Gallbladder is initially identified
- Angle medially until bull's-eye appearance is seen



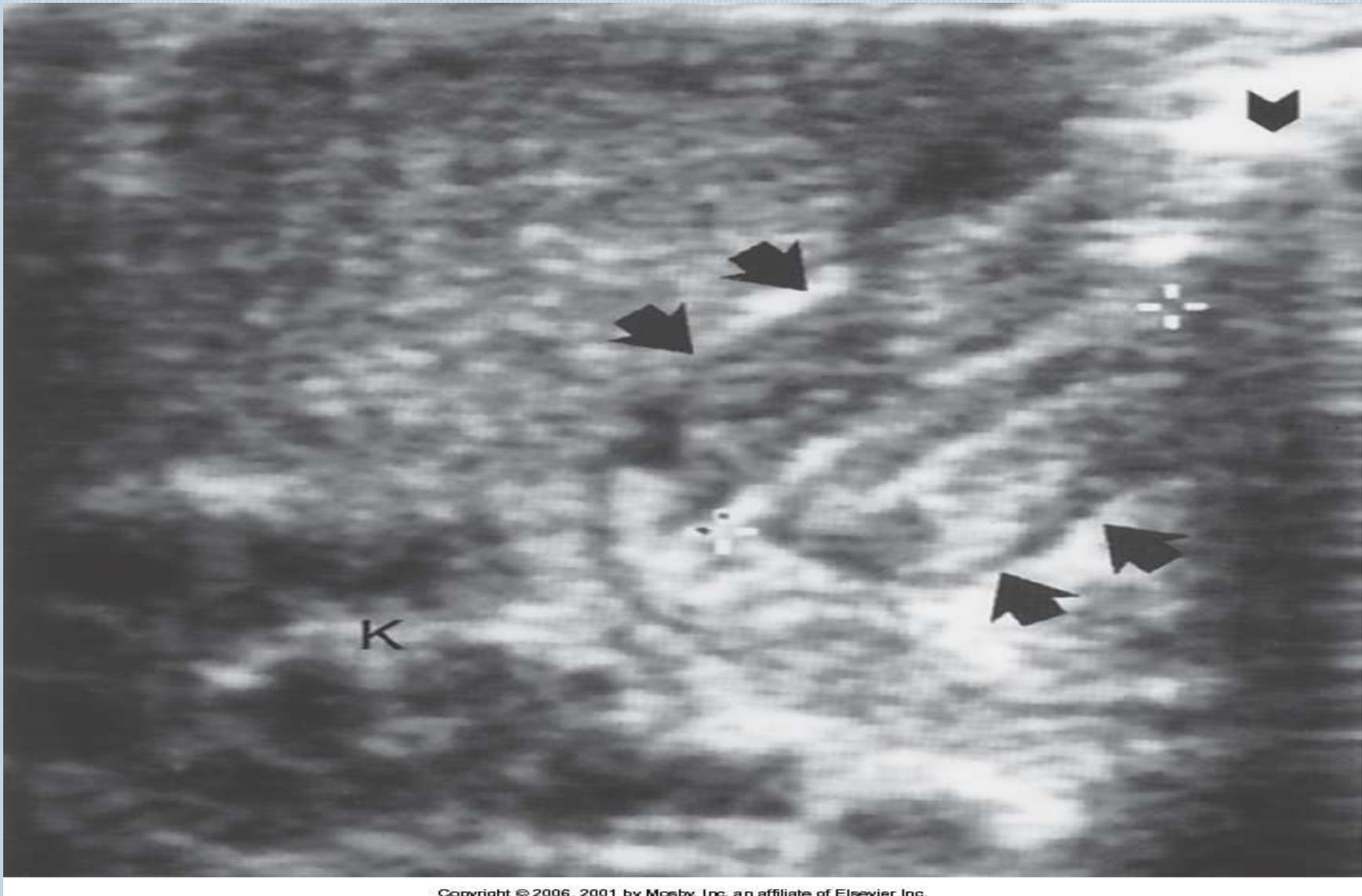
Coronal view of RUQ shows hypertrophied pyloric muscle in transverse section. Diameter of muscle (*arrows*) is measured from outer borders. Muscle thickness (*left arrow to arrowhead*) is measured from outer border to mucosal-muscle interface

Measurements

- Can be made in both short and long axis planes
 - Individual muscle wall thickness
 - Total diameter
 - Length of pyloric canal

Measurements (cont'd)

- Thickness
 - Measured from periphery of hypoechoic muscle to its junction with the echogenic central canal
- Diameter
 - Measured between peripheral margins of hypoechoic muscle layer
- Length
 - Measured from proximal to distal extremes of echogenic central canal



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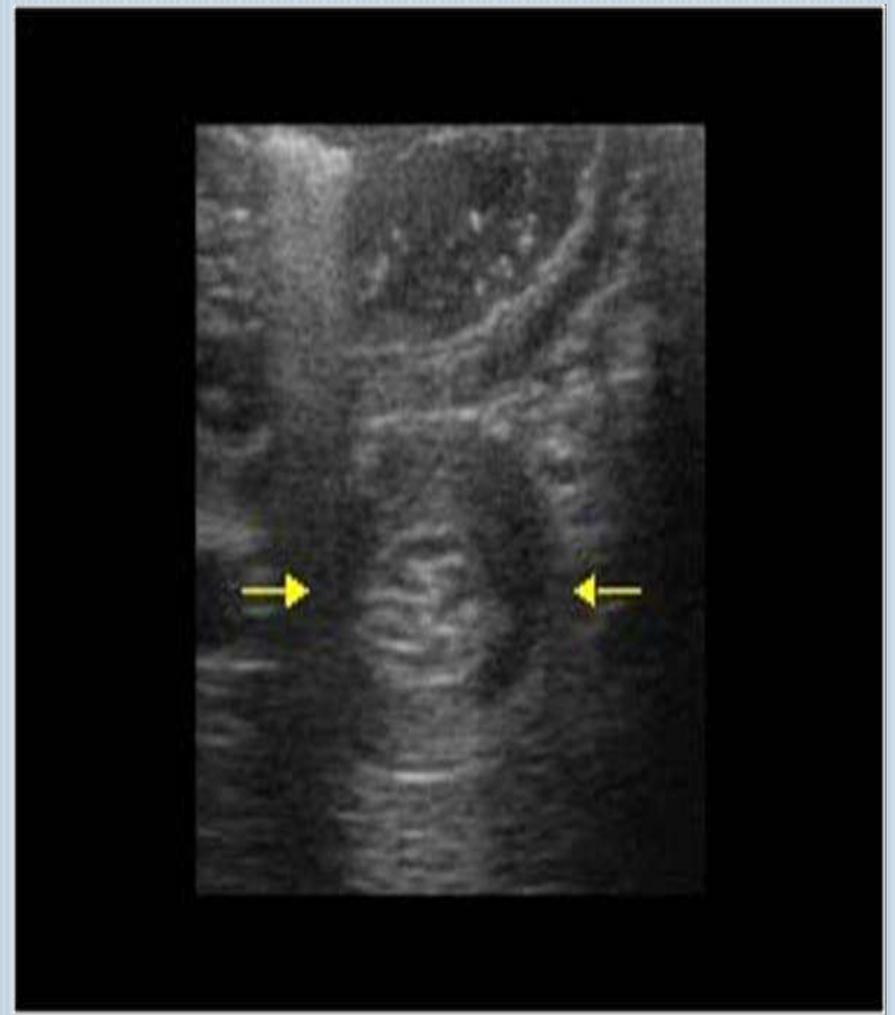
Transverse view of RUQ shows longitudinal extent of hypertrophied pyloric muscle (*arrows*). Calipers measure length of pyloric muscle, which is 20 mm.

Normal Pylorus

Long



Trans



Sonographic Diagnosis of HPS

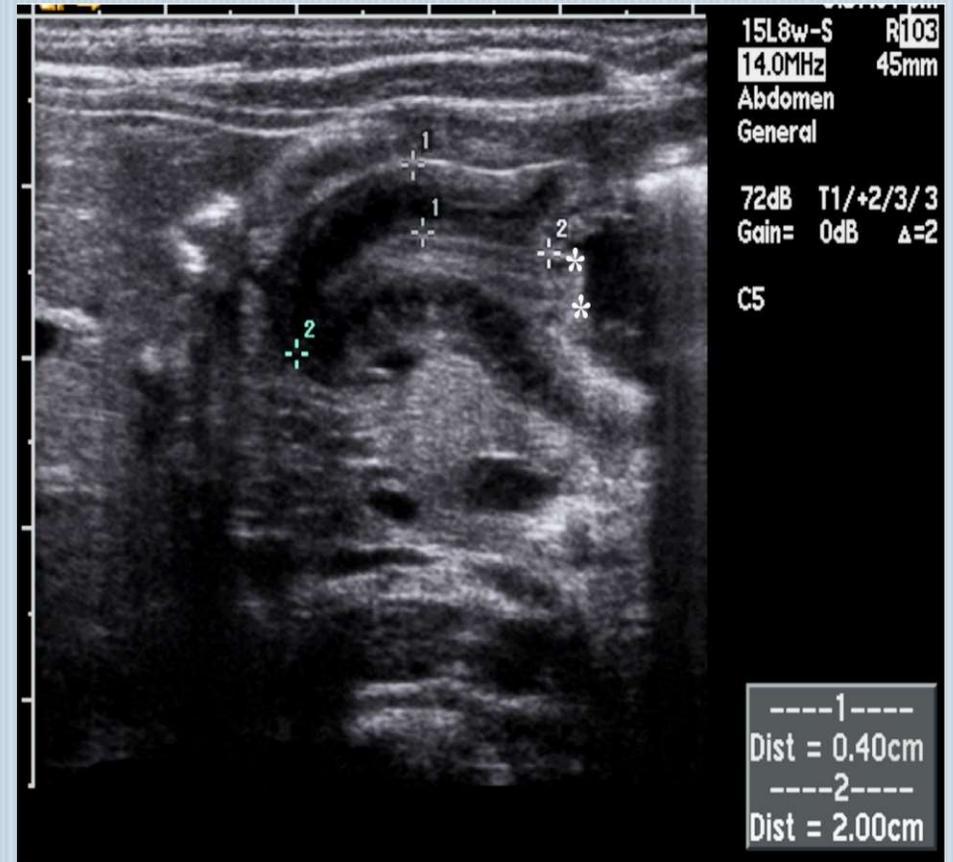
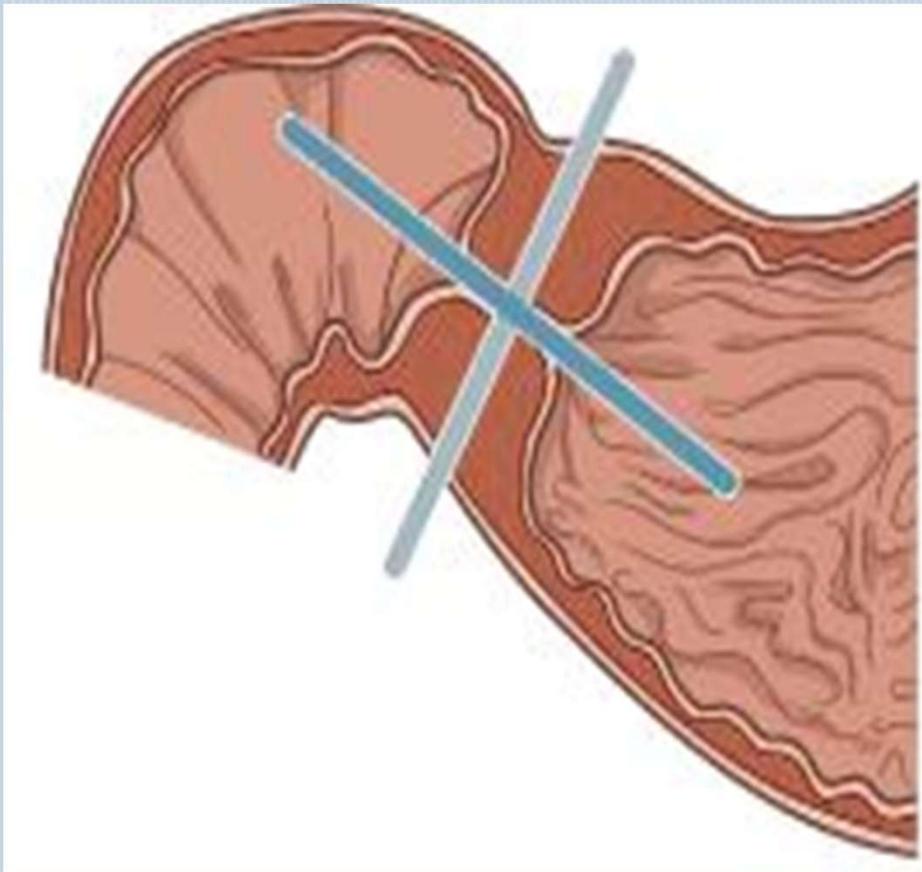
- Depends on following findings:
 - Visualization of hypertrophied pyloric muscle with a canal measuring greater than 15-16 mm
 - Individual pyloric muscle wall thickness greater than or equal to 3.0 mm
 - Pyloric diameter of 10 mm or greater
 - Additional significant finding:
 - Presence of active antegrade and reverse gastric peristalsis

HPS



Positive HPS “bagel” or “donut” sign. **A**, Short-axis view of the hypertrophied pyloric muscle, measuring 3.9 mm demonstrating the *bagel* or *donut* sign. The muscle thickness is measured from the outer border to the mucosal-muscle interface. **B**, Long-axis view in the same 3-week-old neonate.

HPS (cont'd)



If the muscle is thickened and elongated, the mucosa extends into the antrum, and this appearance has been called the “cervix” sign

HPS (cont'd)

- https://youtu.be/_hvzmgbTDxl?si=rr8JM49CXvoYd46m

REVIEW



Webinar on Pediatric GI Pathologies

<https://youtu.be/6QDx5TFbyLQ?si=JdD8gBnbvHVMxZXx>