

# 2025 SDMS Annual Conference

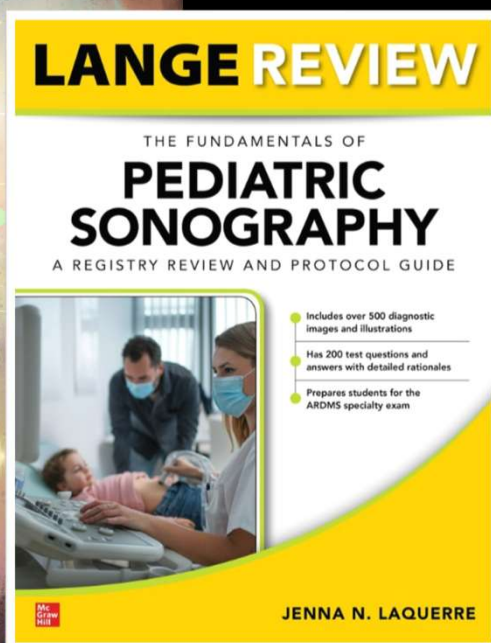
## The Pediatric Imaging Toolkit: Gastrointestinal Imaging and Case Studies



Tara K. Cielma, BS, RT (S), RDMS (AB, OB/GYN, NE), RDCS (FE), RVT, FSDMS

Jenna N. Laquerre, MS, RT (R), RDMS (AB, OB/GYN, PS, BR), RVT

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If you haven't  
already, be sure to  
enter for a  
textbook giveaway  
raffle at the end of  
this presentation!

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## DISCLAIMER

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TeePublic, Digestive Tract Sticker: <https://www.teepublic.com/sticker/6938324-digestive-tract>

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## Objectives

- Understand and apply ultrasound techniques for assessing pediatric **intussusception**, including identification, fluoroscopic reduction, and clinical symptom evaluation.
- Accurately identify **appendicitis** and understand the clinical indications for imaging.
- Review **pyloric stenosis**, imaging assessment, clinical indications, and the Ramstedt procedure.
- Identify and evaluate necrotizing enterocolitis (**NEC**) using sonography and understand its implications for treatment.
- Optimize sonographic equipment settings to **enhance image quality** and **diagnostic accuracy**.



You've Gut This Die-Cut Sticker. Etsy. <https://www.etsy.com/listing/149880160/youve-gut-this-die-cut-sticker-funny>

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## Let's go on a journey...



The Magic School Bus: For Lunch [television series episode image]. Scholastic Entertainment 1995. Screenshot available from: <https://www.dvdtalk.com/reviews/65415/magic-school-bus-takes-a-dive-the/>

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## Bowel- Basics

- Also known as the **intestine**.
- Vital component of the GI tract responsible for **digestion**, absorption of **nutrients**, and elimination of **waste**.
- Divided into two main sections: the **small** intestine and the **large** intestine.
- **Small** intestine: primarily involved in **nutrient absorption**.
- **Large** intestine: **absorbs** water and electrolytes and compacts **waste** into stool.
- Lined with smooth **muscle** and **mucosa**.
- Exhibits coordinated **peristaltic movements** to propel contents forward.



SomethingSciencey Digestive System Waterproof Sticker. Etsy. You've Got This Die-Cut Sticker. Etsy. <https://www.etsy.com/listing/249880160/gowee-gut-this-die-cut-sticker-funny>

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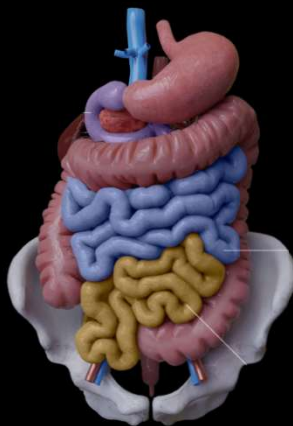
## Bowel - Anatomy

How to distinguish large bowel from small bowel:

Small intestine consists of **3** regions:

**duodenum, jejunum** and **ileum**.

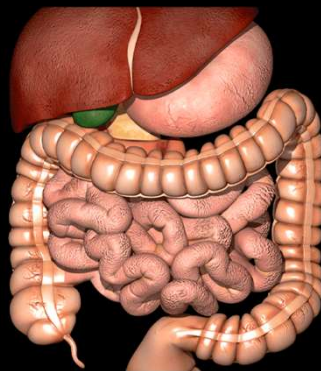
- Centrally located
- Contains valvulae conniventes
- Smaller caliber dimensions



Large intestine is composed of **5** sections:

**cecum, ascending, transverse, descending, and rectosigmoid**

- Peripherally located
- Contains haustrations, taenia coli
- Larger caliber dimensions
- Lacks mesentery (except at transverse and sigmoid colon)



Anatomy app. Small Intestine. Anatomyapp Encyclopedia. SomethingSciencey Digestive System Waterproof Sticker. Etsy. You've Got This Die-Cut Sticker. Etsy. <https://www.etsy.com/listing/249880160/gowee-gut-this-die-cut-sticker-funny>

Kate R. Anatomy of the Large Intestine [color-coded diagram]. In: Role of Short-Chain Fatty Acids in Modulation of Gut Health. ResearchGate; March 2022. Figure 1. Available from: Kate R. Anatomy of the Large Intestine [color-coded diagram]. In: Role of Short-Chain Fatty Acids in Modulation of Gut Health. ResearchGate; March 2022.

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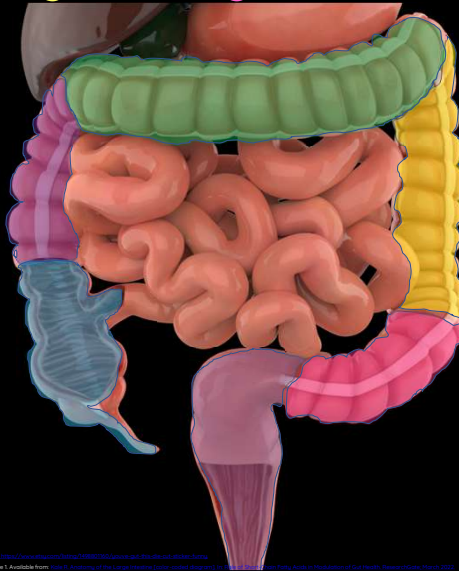
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## Sonography

### A Window Into the Bowel Wall

Ultrasound is a critical component in the evaluation of gastrointestinal disease, with a **sensitivity and specificity capable of matching CT and MRI.**

It is the **only modality able to depict the layers seen at histologic analysis**

US examination allows accurate, real-time surveillance:

- Initial detection of disease
- Progression follow-up in conjunction with clinical symptoms
- Monitor response to treatment



decals. Ultrasound/Sonographer Probe Heart Loops - Sticker Graphic / Decal Sticker [Internet]. Amazon.com. Available from: <https://www.amazon.com/decals/ultrasound-sonographer-probe-heart-loops-sticker-graphic-decal-sticker/dp/B08XJZK1Z1>

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## Bowel

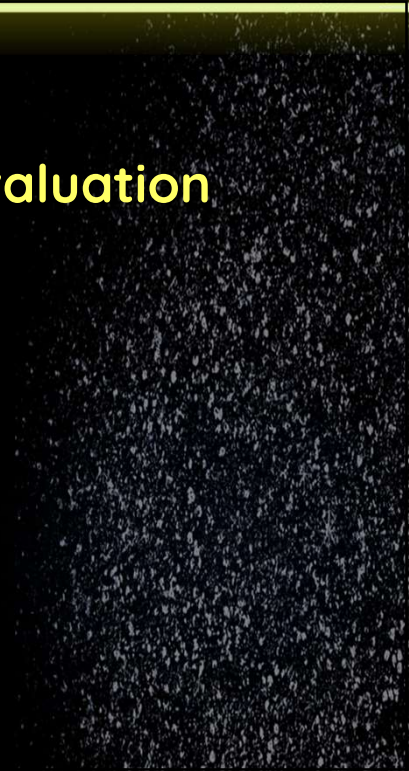
### How to Perform A **Systematic Evaluation**

- Patient position: **Supine** with a **relaxed** abdominal wall
- Start with **low** frequency transducer to gain a **wider** field of view
- Then use **higher** frequency linear transducer for **detailed** evaluation and **characterization**
- **Graded compression** displaces intraluminal gas from overlying bowel loops

Key areas to focus on:

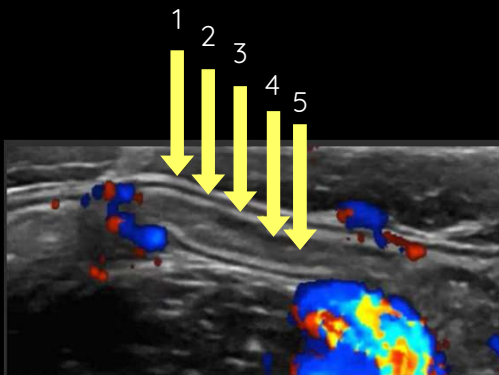


- Wall thickness
- Gut signature
- Perfusion
- Motility (presence or absence of peristalsis, direction of movement)



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## Bowel Sonoanatomy - “Gut Signature”



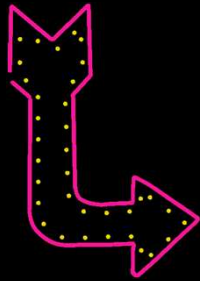
Stratified bowel wall layers  
(*outer to inner*)

1. Serosa - bright
2. Muscularis propria - dark
3. Submucosa - bright
4. Muscularis mucosa - dark
5. Mucosal interface (lumen) - bright

Images on file with author, Cielma T.

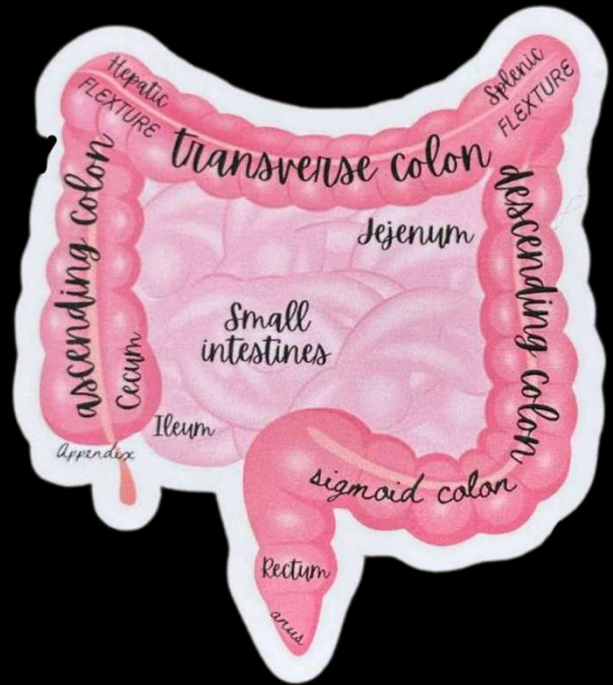
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## Intussusception



Two types

- Large Bowel - Ileocolic
- Small Bowel - Enterenteric



Etsy. Intestine stickers [Internet marketplace collection]. Etsy. [https://www.etsy.com/market/intestine\\_stickers](https://www.etsy.com/market/intestine_stickers).

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## Intussusception- Pathophysiology

- Intussusception is the most common cause of intestinal obstruction in infants and young children.
- Primarily idiopathic (>90%).
- Often triggered by hypertrophied Peyer patches or lymphoid tissue following a viral infection (adenovirus, rotavirus) or gastroenteritis.
- An emergent condition caused by telescoping of bowel. The invaginated segment (intussusceptum) is carried distally and squeezed along with mesentery/vessels within the engulfing segment (intussusciens).

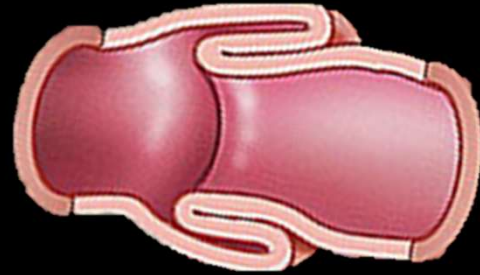
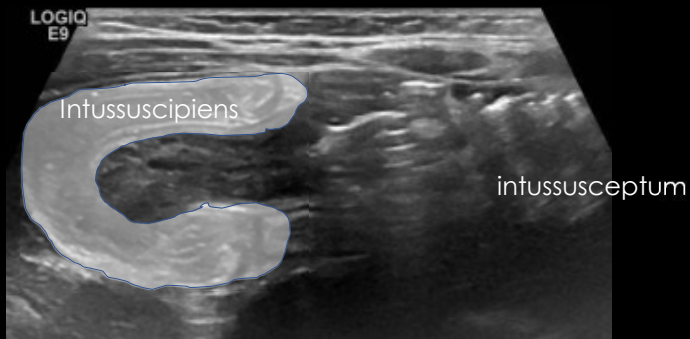
Mesenteric pull > venous congestion > bowel wall edema > vascular compression > compromised flow > potential ischemia, necrosis > risk of perforation or peritonitis



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## Intussusception

### Method of action



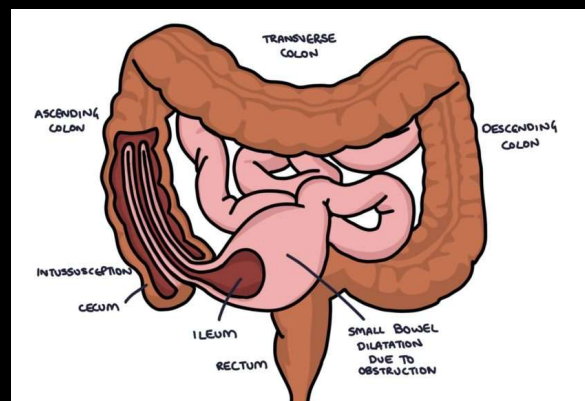
US images on file with author, Cielma T.

Alberta Health Services. Pyloric Stenosis. MyHealth.Alberta.ca. Updated 2023. Accessed August 5, 2025. <https://myhealth.alberta.ca/Health/pages/conditions.aspx?hwid=hp12520>

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## Intussusception- Clinical Relevance

- Early detection allows for **non-surgical reduction** using air, contrast or water enemas (effective in most cases).
- **Delay** in diagnosis increases the likelihood of requiring **surgical intervention** and raises the risk of **complications**.
- Recognizing both classic and atypical presentations is critical to ensuring **timely intervention and optimal outcomes**.



Zero to Finalis Pediatric Intussusception diagram [digital medical illustration]. ZeroToFinalis.com. Published date unknown. Available from: <https://zerotofinalis.com/paediatrics/gastro/intussusception/>.

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## Intussusception - Presentation

### Typical intussusception:

- Occurs between 6 – 36 months of age
- Typically ileocolic (>80%)
- Location – right colon
- An outer diameter of >2.5 cm and length >3 cm are suggestive of ileocolic intussusception.
- In older children, identifiable lead points such as Meckel's diverticulum, polyps, or lymphoma become more common.



Classic triad: intermittent colicky pain, currant-jelly stool, palpable mass

Plut D, Phillips GS, Johnston PR, Lee EY. Practical imaging strategies for intussusception in children. AJR Am J Roentgenol. 2020;215(6):1449-1463. doi:10.2214/AJR.19.22445

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## Intussusception Pathologic Lead Point (PLP)



### Most Predictive Factor:

- > 2 years is most strongly associated with a higher chance of having an identifiable cause (anatomical abnormality) driving the intussusception.
- This should prompt both the clinician or sonographer to look more carefully for a mass.

### Other Risk Factors:

- Recurrent intussusception (especially >2 episodes)
- Atypical location (e.g., small bowel-small bowel)
- Prolonged symptoms (>24-48 hours)
- Failed enema reduction
- Underlying syndromes (e.g., Peutz-Jeghers, Henoch-Schönlein purpura, cystic fibrosis)

### Imaging Pearls:

- Carefully evaluate for a lead point mass on ultrasound
- Use color Doppler and post-reduction scanning if clinically indicated
- Clinicians may consider additional imaging (e.g., MRI, contrast-enhanced US) in equivocal case

Redbubble. Cute lymph nodes sticker design [digital illustration]. Redbubble Image ID: 1945565170. Available from: <https://www.redbubble.com/shop/lymph+nodes+stickers>.

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## Bowel - Sonographic Technique

Optimal evaluation relies on **decreased bowel motility**.

A **4-6 hour fast** is recommended to fully assess the gastrointestinal tract - **emergent conditions preclude this**.

- Use **graded compression sonography** to displace bowel gas when needed
- Transducer selection:
  - A lower frequency **3.5 - 5 MHz curved probe** to investigate deep structures including the extent of lesion and any ancillary findings
  - A higher frequency **4 - 20 / 9 - 15 MHz linear probe** to assess bowel wall layers, characterize surrounding mesentery, superficial structures and specific regions of interest



Redbubble. Cute ultrasound stickers [online shop]. Redbubble. <https://www.redbubble.com/shop/cute+ultrasound+stickers>.

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## Approach

*This is how we do it*



**Large bowel:** Start at the right lower quadrant and identify the iliac vessels

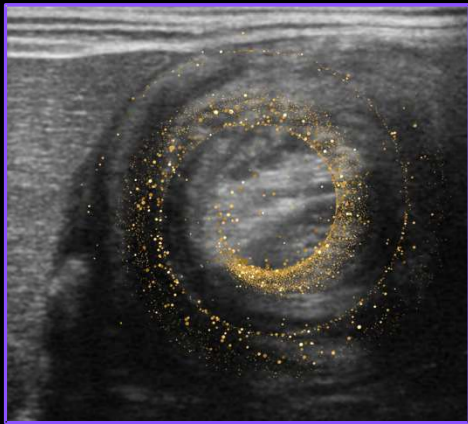
- the first loop of bowel to cross medial to lateral will be the terminal ileum
- follow this loop to the ileocecal valve to find the cecum
- sweep superior up the ascending colon and follow it to the hepatic flexure
- scan clockwise following the transverse colon, splenic flexure, left colon and rectosigmoid colon

**Small bowel:** Locate the terminal ileum in the right iliac fossa and follow it proximally with **graded compression**

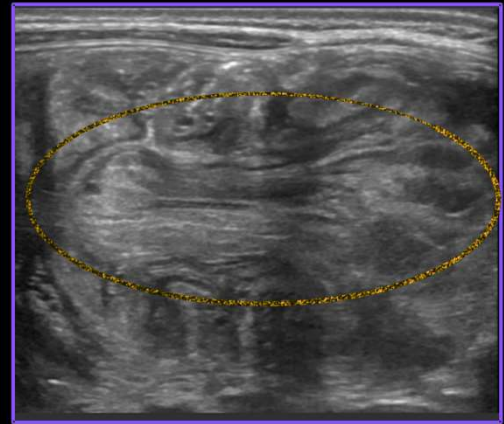
- Sweep all 4 abdominal quadrants in long and axial planes to evaluate the central small bowel loops

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## Intussusception Signs to look for



- Transverse scan:  
"Doughnut" rings /  
"Target" lesion
- Longitudinal scan:  
"Sandwich" or  
"Pseudo kidney"  
sign



Shutterstock. Bowel obstruction intussusception healthcare illustration. Shutterstock Image #2403725881. Available from: <https://www.shutterstock.com/image-vector/bowel-obstruction-intussusception-healthcare-illustration-2403725881>

Images on file with author, Cielma T.

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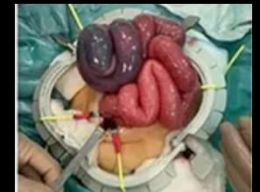
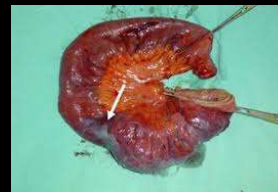
## Intussusception - Sonoviability

**IMPORTANT!**

- Color Doppler must be used to assess bowel wall perfusion and detect signs of ischemia.
- Preserved or increased flow suggests early, viable intussusception, while absent or diminished flow may indicate necrosis.
- Presence of trapped fluid within an intussusception correlates significantly with ischemia and irreducibility.
- Lack of perfusion, free fluid, and bowel wall thinning are poor prognostic signs requiring urgent intervention.

### Note: Optimize color Doppler

- use a low wall filter, increase color gain until background noise just begins to appear, reduce the pulse repetition frequency (PRF) for slow flow detection, and ensure the color box is appropriately sized and centered over the area of interest.



US images on file with author, Cielma T.

Romano G, Frediani S, Ala P, Bertocchini A, Pardi V, Accorri A, Isenra A. Case Report: An unusual case of wide based ileal intussusception associated with intestinal valvulae in an 8-month-old infant. Front Pediatr. 2024;12:1563731. doi:10.3389/fped.2024.1563731  
Tiwari H, Jiang S-X. Gross appearance of resected necrotic specimen in intussusception [figure]. In: Diabetic ketoacidosis-associated gangrenous ischaemic colitis masquerading as acute pancreatitis and differentiated using computed tomography. ResearchGate. 2022. Available from: <https://www.researchgate.net/publication/358101010-Diabetic-ketoacidosis-associated-gangrenous-ischaemic-colitis-masquerading-as-acute-pancreatitis-and-differentiated-using-computed-tomography>

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## Intussusception - Small Bowel

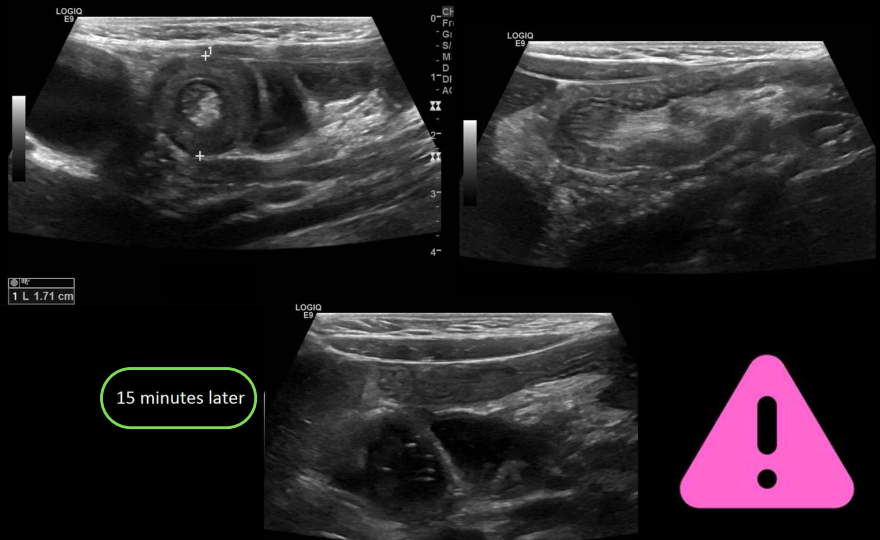
### Enteroenteric

#### Small-Bowel Intussusception

- If small-bowel intussusception is:
  - Short segment (<3 cm)
  - Thin-walled
  - Asymptomatic or mild symptoms

These often resolve spontaneously and just need short-term observation

... but not always



Sonographic Tendencies (Henry Suarez RDMS, RVT). Published November 26, 2016. Available from: Sonographic Tendencies. "Intussusception"

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## Intussusception - SBI Associations

- Cystic fibrosis
- Meckle's diverticulum
- Duplication cysts
- Henoch-Schönlein purpura (IgA vasculitis)
- Crohn's disease
- Celiac disease
- Peutz-Jeghers
- Juvenile polyps
- Lymphoma



Sonographic Tendencies (Henry Suarez RDMS, RVT). Published November 26, 2016. Available from: Sonographic Tendencies. "Intussusception"

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## Case Report X:

**Patient:** 2-year-old male

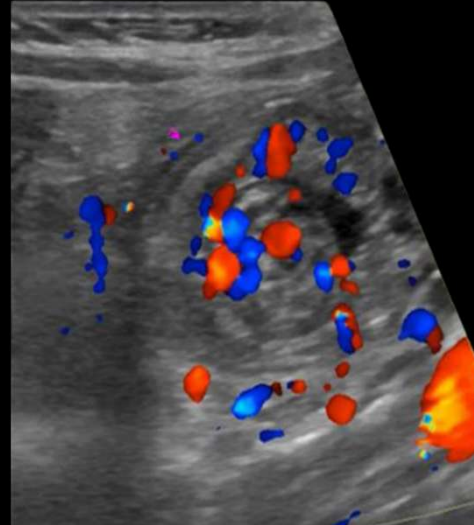
**Presentation:** Colicky abdominal pain

**Initial management:** ED referred for intussusception eval versus appy

Target sign - 

Case closed?

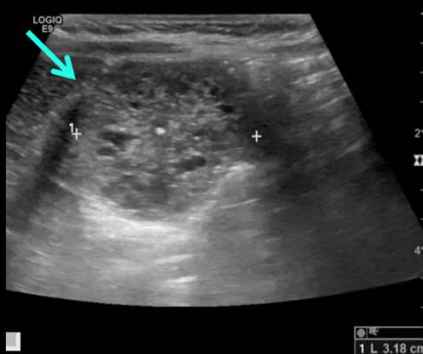
Images on file with author, Cielma T.



RUQ - transverse with color doppler

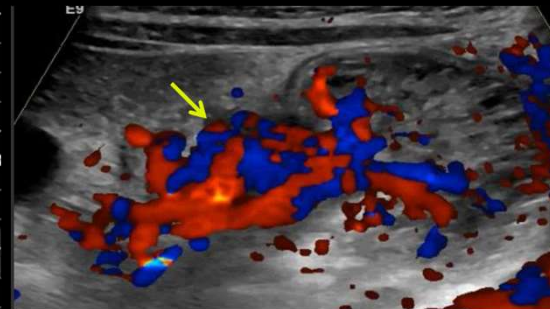
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## Case Report X:



RUQ - long and transverse with color doppler

Images on file with author, Cielma T.



- Heterogeneous
- Echogenic
- Mass-like intraluminal nodule
- Hypoechoic cystic spaces near the hepatic flexure of the colon measuring **3 cm size**
- **Vascular pedicle present**

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## Case Report X:

### Intestinal polyp causing colocolic intussusception



- Abnormal mucosal growths projecting into the intestinal lumen.
- Most commonly occur in the colon, but can be found throughout the GI tract.
- Benign or premalignant; risk of malignancy depends on type and size.

WebPathology. Hamartomatous polyps of the large bowel [digital image]. WebPathology. Published date unknown. Available from: <https://www.webpathology.com/images/gastrointestinal/large-bowel/hamartomatous-polyps>

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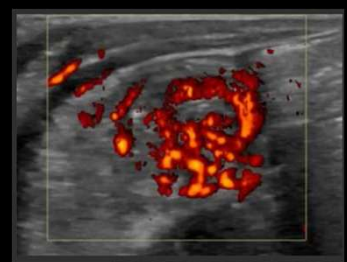
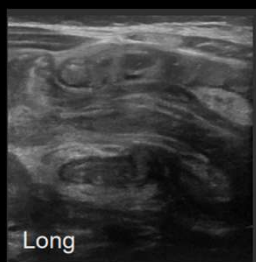
## Case Report X:

**Patient:** 2-month-old male with intermittent abdominal pain, vomiting, and lethargy

**Presentation:** 3 episodes of ileo-ileocolic intussusception within 36 hours

**Initial management:** Air enema reduction twice

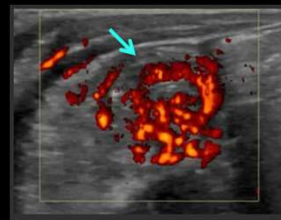
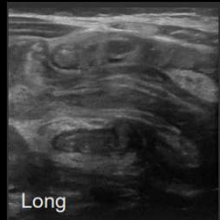
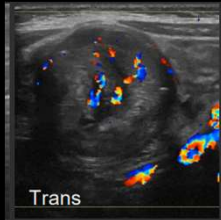
Recurrent symptoms prompted further, more detailed evaluation



Images on file with author, Cielma T.

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## Case Report X:



Ileocecal intussusception, with a possible lead point  
(x3 intuss. in 36 hours)

increased vascularity of ROI

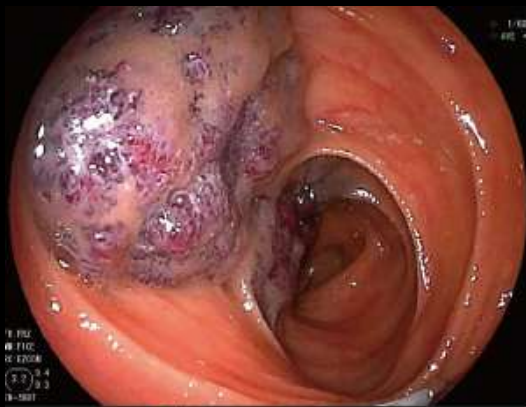
Contrast enema post-reduction:

Filling defect @ base of cecum

Images on file with author, Cielma T.

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## Case Report X: Infantile hemangioma of cecum



- Rare PLP: Infantile hemangiomas are the most common benign tumors of infancy but rarely occur in the GI tract.
- A hemangioma in the cecum is particularly rare.
- Important clue: Recurrent intussusception in infants <3 mos suggests PLP
- Treatment: Surgical resection required for definitive management

Marinis A, Yiallourou A, Samanides L, et al. Abdominal CT demonstrating "target" or "sausage"-shaped intussusception with a layering effect [figure]. World J Gastroenterol. 2009;15(4):407-411. doi:10.3748/wjg.15.407

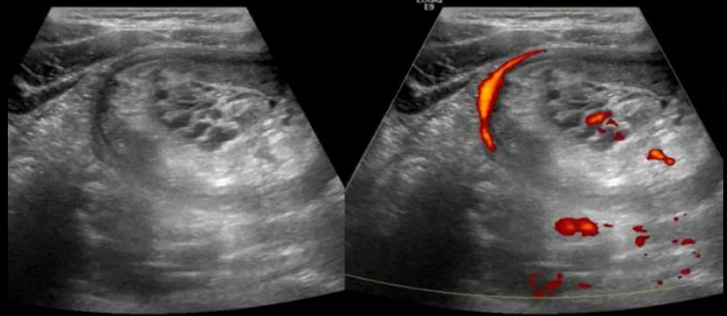
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## Case Report X:

**Patient:** 11-year-old female

**Presentation:** Severe acute onset periumbilical pain, emesis, and leukocytosis

**Initial management:** ED referred for appy versus ovarian torsion versus...



Right abdomen: transverse w/o and w/ power doppler

11...?

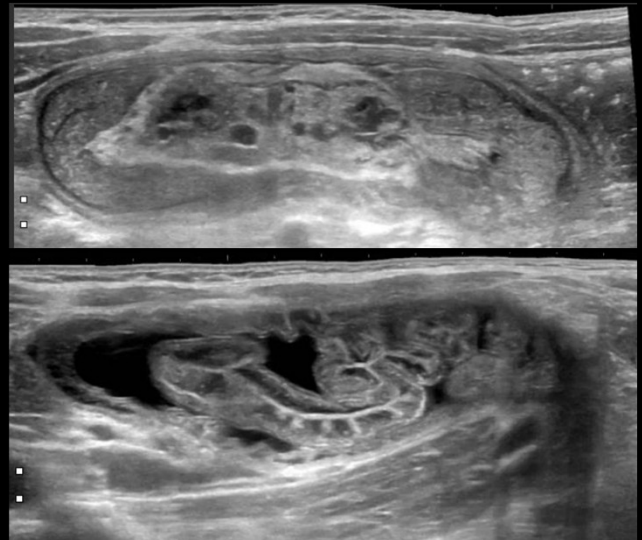
Images on file with author, Cielma T.

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## Case Report X:



Observation reveals apparent lesion



Panoramic views of ROI

Images on file with author, Cielma T.

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## Case Report X: Peutz-Jeghers



Extensive small bowel intussusception, secondary to polyps in jejunum

US image on file with author, Cielma T.



- Peutz-Jeghers Syndrome is a rare autosomal dominant disorder characterized by **mucocutaneous pigmentation** and **multiple hamartomatous polyps**, primarily in the **small intestine**.
- **Mutations** in the **STK11** gene lead to **abnormal tissue growth** and **increased risk** of intussusception, GI bleeding, and malignancy across multiple organ systems.
- Imaging plays a key role in **surveillance** and **acute evaluation**, with MR enterography preferred for polyp screening and ultrasound or CT used to assess **complications** like obstruction or intussusception.

Pathology Outlines. Peutz-Jeghers hamartomatous polyp of colon [digital histology image]. PathologyOutlines.com. Available from: <https://www.pathologyoutlines.com/topic/colontumorPeutz.html>. Accessed July 3, 2025.

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## Diagnostic & Supportive Procedures Enema Reduction

- **Air enema** (preferred in many centers): uses air pressure under fluoroscopic or ultrasound guidance
- **Hydrostatic enema**: uses saline or contrast material
- Success rate: ~80-90% in typical, uncomplicated ileocolic cases

### Requires:

- Stable vital signs
- No signs of perforation or peritonitis
- Access to imaging (fluoroscopy or ultrasound)

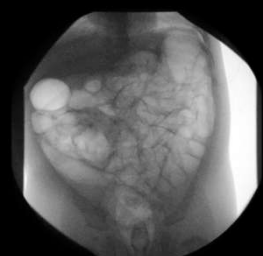
**Fluoroscopy-guided pneumatic reduction performed in prone position in 12-month-old male**



large mass noted



decreasing size



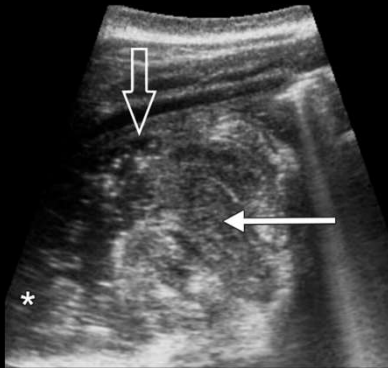
no mass

Plut D, Phillips GS, Johnston PR, Lee EY. Practical imaging strategies for intussusception in children. AJR Am J Roentgenol. 2020;215(6):1449-1463. doi:10.2214/AJR.19.22445

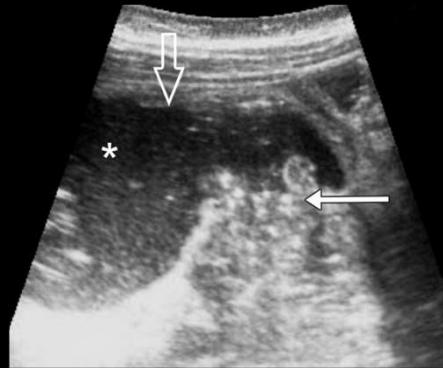
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## Ultrasound-Guided Hydrostatic Reduction

Ultrasound-guided hydrostatic reduction performed in prone position in 3-year-old male



Ultrasound shows colon (open arrow) filled with saline (asterisk) with loops of small bowel (solid arrow) located within lumen of colon



Ultrasound shows signs of successful reduction of intussusception including open ileocecal valve (solid arrow) and reflux of saline (asterisk) from cecum (open arrow) into small bowel.

Plut D, Phillips GS, Johnston PR, Lee EY. Practical imaging strategies for intussusception in children. AJR Am J Roentgenol. 2020;215(6):1449-1463. doi:10.2214/AJR.19.22445

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## Diagnostic & Supportive Procedures

### Surgical Intervention

- Indicated if:
  - Enema reduction fails
  - Signs of perforation, peritonitis, or severe ischemia
  - PLP is suspected or confirmed
- Procedures may include:
  - Manual reduction of the intussusception
  - Resection of necrotic bowel
  - Lead point excision (e.g., Meckel diverticulum)



Thomason M, Latimer C. Abdominal ultrasound images of intussusception in dogs; showing concentric rings ("target" sign). Clinician's Brief. April 2020. Available from: <https://www.cliniciansbrief.com/article/intussusception-reduction>.

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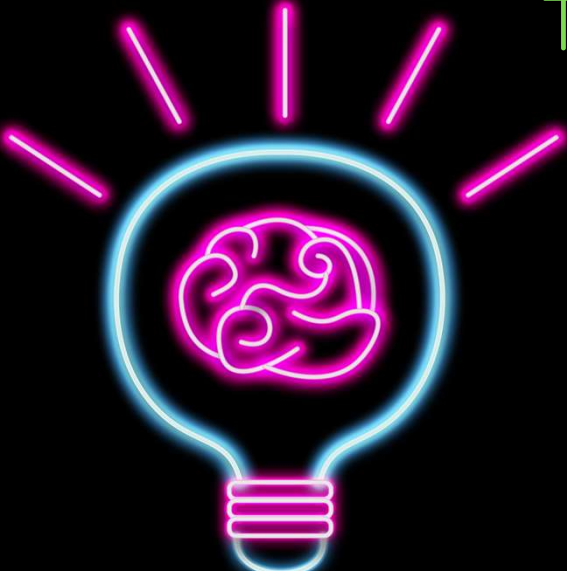


## Test your knowledge

Which of the following factors is most predictive of a **pathological lead point** in pediatric intussusception?

- A) Patient age <2 years
- B) Recurrent intussusception
- C) Presence of diarrhea
- D) Successful air enema reduction

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## Test your knowledge

Which of the following factors is most predictive of a **pathological lead point** in pediatric intussusception?

**B) Recurrent intussusception**

Recurrent or atypical presentations raise suspicion for a pathological lead point (e.g., Meckel's diverticulum, polyp)

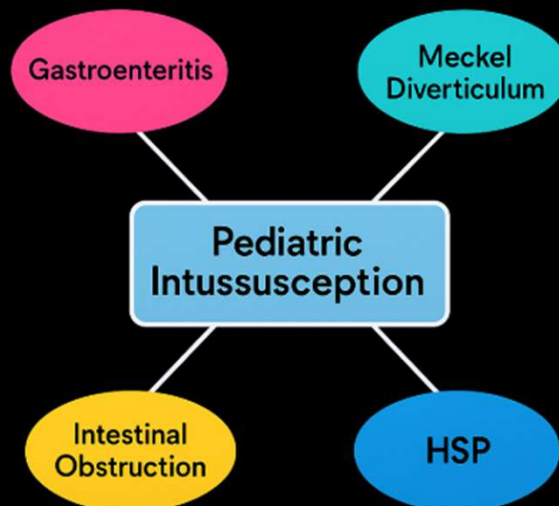
38

## Intussusception- Review

Feature	Large Bowel (Ileocolic)	Small Bowel (Enteroenteric)
1. Etiology	Idiopathic in most cases; viral illness, lymphoid hyperplasia common	Often transient and incidental; lead points rare
2. Clinical Presentation	Symptomatic: colicky pain, vomiting, bloody stools	Often asymptomatic or mild nonspecific symptoms
3. Ultrasound Appearance	Classic "target" or "pseudokidney" sign; layered concentric rings	Smaller, thinner-walled target with central mesenteric fat or vessels
4. Size	Typically >3 cm in length, >2.5 cm diameter	<3 cm in length, often <2 cm in diameter
5. Management Approach	Requires urgent enema reduction or surgical evaluation	Self-resolving, observation is typically sufficient
6. Risk of Complications	Higher: obstruction, ischemia, perforation if untreated	Low risk; rarely progresses or requires intervention

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## Differential Diagnoses



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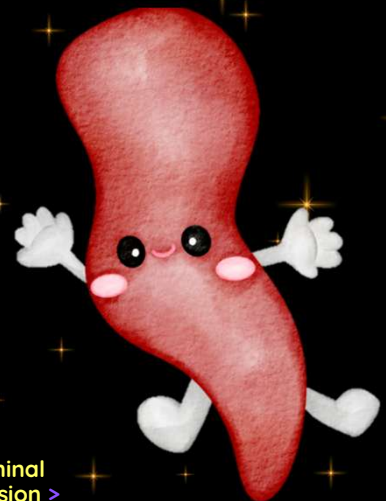
let's append our knowledge with a dive into appendicitis

41

## Appendix - Pathophysiology

- Appendicitis is the common pediatric abdominal surgical emergency, peaking in incidence between ages 10-12
- Male > female: 1.4 : 1
- Most commonly caused by obstruction of the appendiceal lumen.
- Common triggers include lymphoid hyperplasia (often post-viral), fecaliths, infection, or foreign bodies.
- Without treatment, the risk of rupture and peritonitis increases significantly within 36-72 hours.

Luminal obstruction > mucus accumulation & distension > increased intraluminal pressure > vascular congestion > wall ischemia > bacterial overgrowth & invasion > risk of perforation, abscess and peritonitis



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## Appendicitis - Presentation

### Typical appendicitis:

- Periumbilical pain migrating to the right lower quadrant (McBurney's point) is 'classic'.
- Nausea, vomiting, and anorexia are common early symptoms.
- Rebound tenderness, guarding, and localized peritonitis develop as inflammation progresses.
- In the pediatric & geriatric population, presentation may be atypical or delayed, increasing risk of perforation.

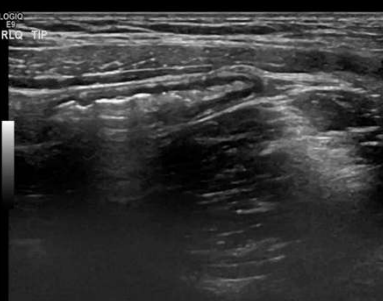
**Classic triad: abdominal pain (RLQ), nausea/vomiting, anorexia**  
(Though only 50–60% of patients present with all three.)



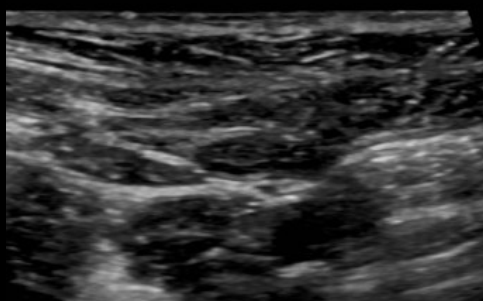
Singh JP, F Mariadason J. Role of the simple clinical diagnostic triad in the diagnosis of acute appendicitis. Int J Anat Radiol Surg. 2016;5(3):1-4. doi:10.7860/IJARS/2016/20083/2191  
Gaillard. Acute appendicitis. Radiopaedia.org. <https://radiopaedia.org/articles/acute-appendicitis-2>. Published May 5, 2024.

43

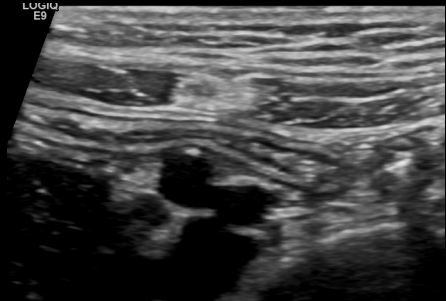
## The Normal Appendix



Air-filled



Compressible

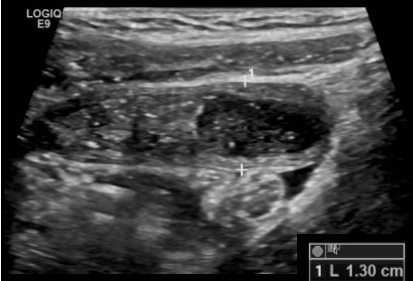


Blind ending

Images on file with author, Cielma T.

44

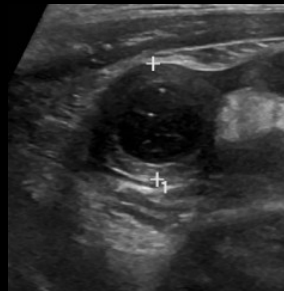
## Abnormal "Classic" Appendicitis



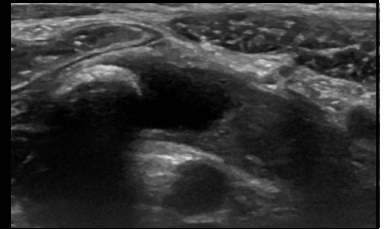
Diameter >6mm



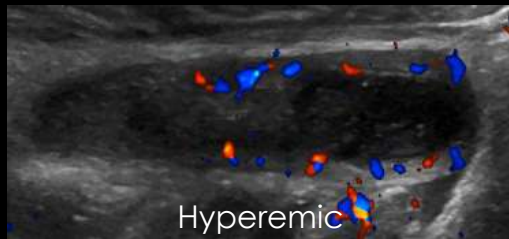
Wall >2 mm



Non-compressible



Appendicolith



Hyperemic

Images on file with author, Cielma T.

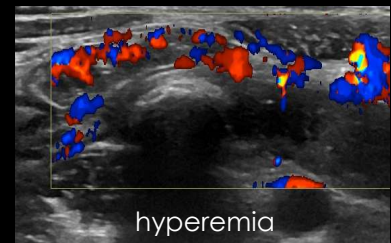
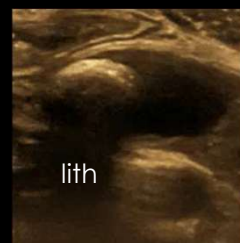
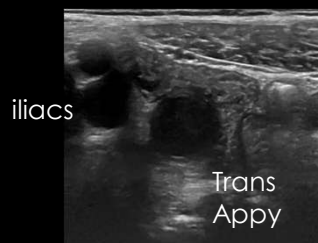
45

## Case Report X

- 8-year-old male
- Periumbilical pain x 3 days
- ED referred for appy eval versus torsion versus intussusception versus...



Panoramic view



hyperemia

Images on file with author, Cielma T.

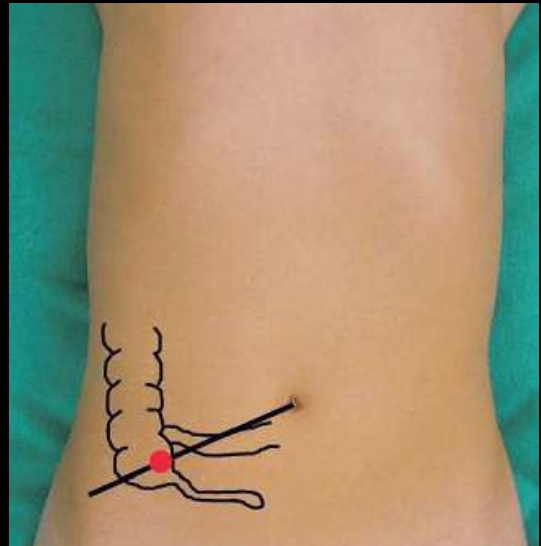
46

## What if it isn't so obvious?

### *What we are taught*

#### Classic position:

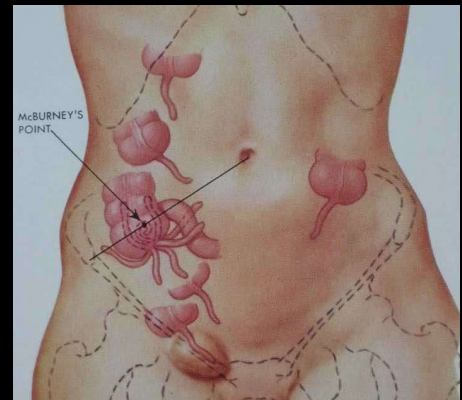
- The appendix is anterior to the right iliac vessels
- “Just locate McBurney’s point!”



47

## What experienced sonographers **know**

- The pediatric appendix can be literally **anywhere** — retrocecal, paracecal, pelvic, subhepatic, or **mimicking** the ileum, ureter, ovarian vein, lymph nodes, etc.
- **False positives** can occur from reactive edema from IBD, CF, sickle cell and PID (associated with thicker wall ie >6mm)
- **Dynamic scanning technique is crucial** — this is an extremely operator dependent exam.
- A **systematic approach and protocol** should be followed along with graded compression, multiple patient positions, pre- and post-void imaging and... **patience**.



**The appendix is a “wanderer” — textbook anatomy is the exception, not the rule.**

**Experienced sonographers rely on technique, not assumptions.**

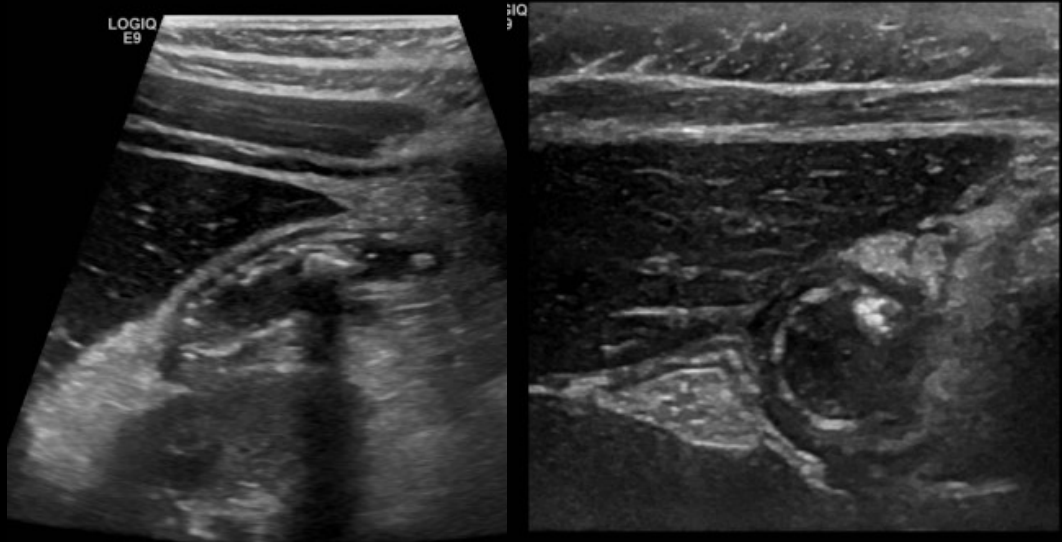
48



## Case Report X

*This is how we do it*

- 10-year-old male
- “All over” pain, anorexia
- ED referred for abdomen complete US + appy



Images on file with author, Cielma T.

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## Case Report X

### Subhepatic Appendicitis

- A **subhepatic appendix** lies adjacent to the gallbladder, often **mimicking acute cholecystitis** on clinical exam and imaging.
- Ultrasound may falsely suggest a **normal RLQ**, leading to delayed or missed diagnosis if the appendix is not visualized.
- **Clinical overlap** includes RUQ pain, positive Murphy's sign, and leukocytosis.
- Subhepatic appendicitis accounts for ~1% of all appendicitis cases, but the diagnostic pitfall is **disproportionately common in toddlers**.

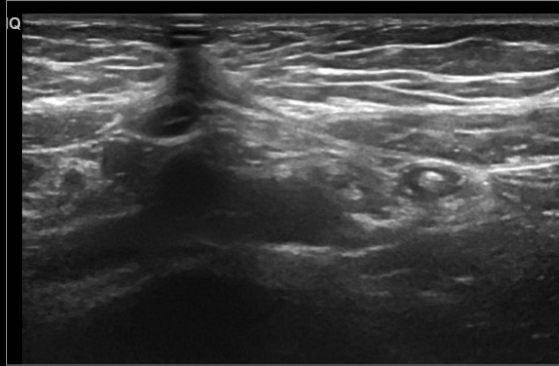


Images on file with author, Cielma T.

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## Case Report X

- 4-year-old female
- Periumbilical pain x few hours
- ED referred for appy eval versus torsion versus intussusception versus...



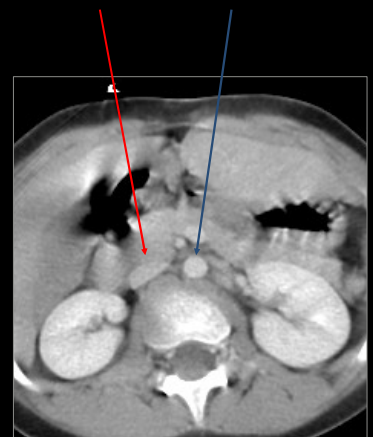
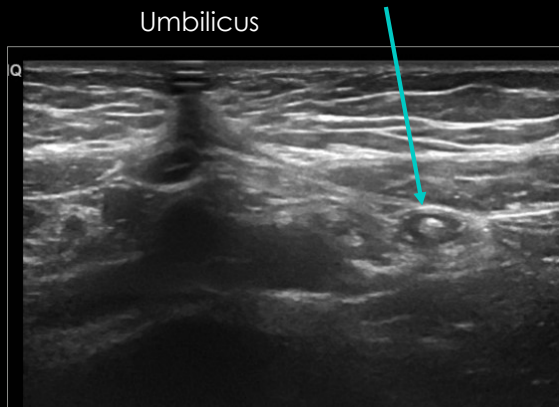
Images on file with author, Cielma T.

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## Case Report X

### Malrotation; appx wnl

- Intestinal malrotation results from **incomplete rotation** of the midgut during embryonic development, leading to **abnormal position of bowel** and mesenteric vessels.
- In this case, the small bowel is **displaced into the right hemiabdomen**, with the colon localized to the left — a hallmark of malrotation.
- A normal appendix was identified to the left of midline.

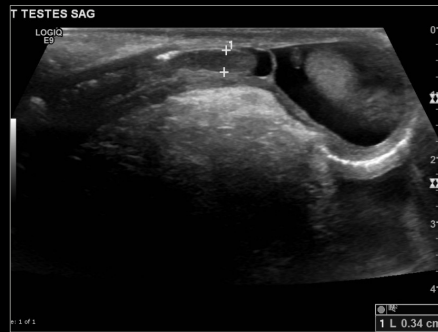


Images on file with author, Cielma T.

52

## Case Report X

- 7-year-old male
- Periumbilical / pelvis pain x <1 day
- ED referred for appy eval versus torsion versus nephrolithiasis



Right testicle



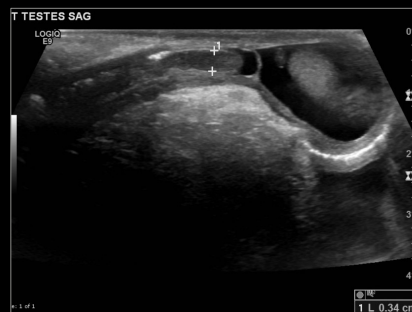
Transverse scrotum

Images on file with author, Cielma T.

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## Case Report X Amyand's hernia

- Amyand's hernia refers to the **appendix** within an inguinal hernia sac.
- This is a **mimic** of incarcerated hernia or testicular torsion.
- Occurs in **~1%** of hernias; Inflammation may remain localized, delaying overt peritoneal signs.
- Diagnosis is often **incidental** during surgery or imaging.



Images on file with author, Cielma T.

Michalinos A, et al. Am J Surg. 2014;207(6):989-995

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But I still  
haven't found  
what I'm looking for...



[Ultrasonography](#). 2019 Jan; 38(1): 67–75.

PMCID: PMC6323308

Published online 2018 May 7. doi: [10.14366/usg.17062](#)

PMID: [30016853](#)

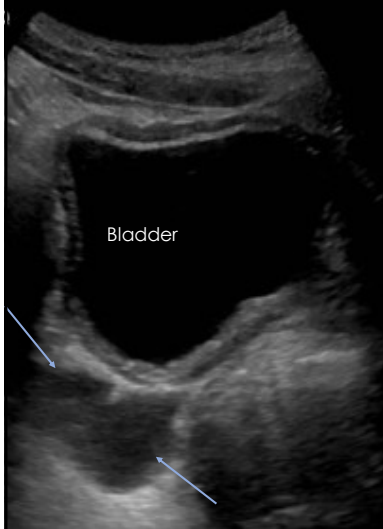
Improving the value of ultrasound in children with suspected  
appendicitis: a prospective study integrating secondary  
sonographic signs

[Tristan Reddan](#),<sup>1,2</sup> [Jonathan Corness](#),<sup>1</sup> [Fiona Harden](#),<sup>3</sup> and [Kerrie Mengersen](#)<sup>2</sup>

If the appendix remains non-visualized, what can we do?

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## Use Secondary Signs



Free fluid



Abscess formation



Mesenteric edema +/- lith

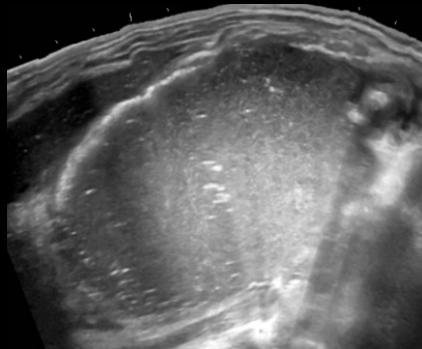
Images on file with author, Cielma T.

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## Case Report X

- 23-month-old female
- Fever, irritability, 2 weeks of abdominal pain
- Atypical presentation and very VERY difficult evaluation due to extreme discomfort.
- ED sent over for... EVERYTHING

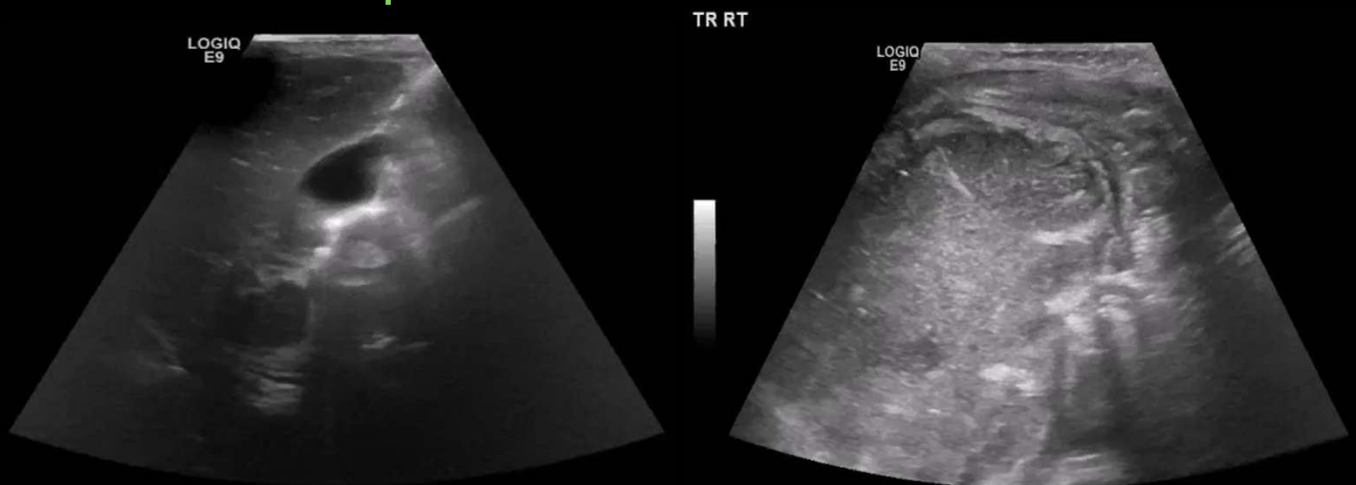


Panoramic image of RUQ

Images on file with author, Cielma T.

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## Case Report X



Images on file with author, Cielma T.

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## Case Report X

### Appendiceal perforation with abscess

- 30–75% of appendicitis in children <3 years presents with perforation, and 33–50% have abscess on admission due to atypical symptoms and delayed diagnosis
- Elevated CRP (>34 mg/L), prolonged symptom duration (>35 hrs), and presence of appendicolith strongly predict perforation and abscess formation
- Perforated appendicitis is the most common cause of pediatric intra-abdominal abscesses; ultrasound sensitivity falls to ~70% in toddlers, necessitating CT or MRI for definitive evaluation
- Non-operative management (IV antibiotics ± percutaneous drainage) achieves over 80% success in appendiceal abscesses; interval appendectomy ~6–8 weeks later is common, especially if appendicolith is present



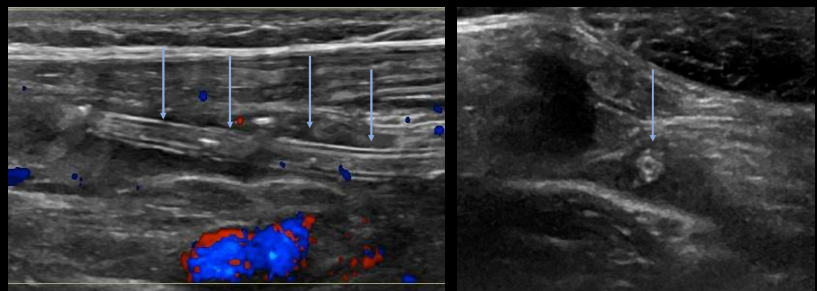
Appendiceal perforation with localized abscess formation

Li H. Non-operative treatment strategy for appendiceal abscess in children. *Frontiers in Pediatrics*. 2023;11:1234820. doi:10.3389/fped.2023.1234820  
Li D, Zhang Z, Wan J, et al. Clinical features and predictors of perforated appendicitis in infants and toddlers under 3: a two-center retrospective study. *Sci Rep*. 2025;15:14338. doi:10.1038/s41598-025-99293-1  
Nepomuceno H, et al. Nonoperative management of appendicitis in children. *PMC*. 2021.

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## Case Report X

- 14-year-old male from out of state
- Pain x 6 hours. Pain started suddenly and rapidly progressed. Patient states he was eating a burger at lunch and swallowed something hard. Last BM about 2 hours after onset of pain and was non bloody
- ED sent over for abdominal survey



Images on file with author, Cielma T.

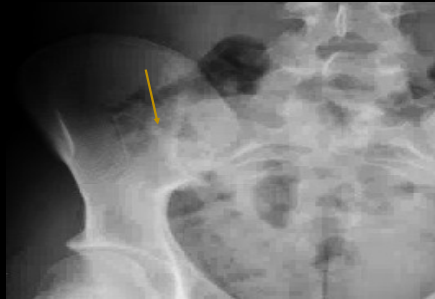
60

## Case Report X

### Foreign body

- Foreign body retention in the appendix is **rare** **but** can directly cause appendicitis or perforation.
- History** is your greatest tool.
- Management** hinges on object characteristics and patient findings:  
**Small, blunt, and mobile objects** → often pass spontaneously under observation.

**Sharp, large (>2.5 cm), or lodged near the appendix** → warrant surgical or endoscopic retrieval.



AXR: Linear radiopaque FB



the FB

Xray image on file with author, Cielma T.

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## Case Report X

- 15-year-old male
- recent history of ruptured appendicitis s/p appendectomy presents w RLQ pain, fever, vomiting and WBC of 15k
- ED sent over for abdominal survey



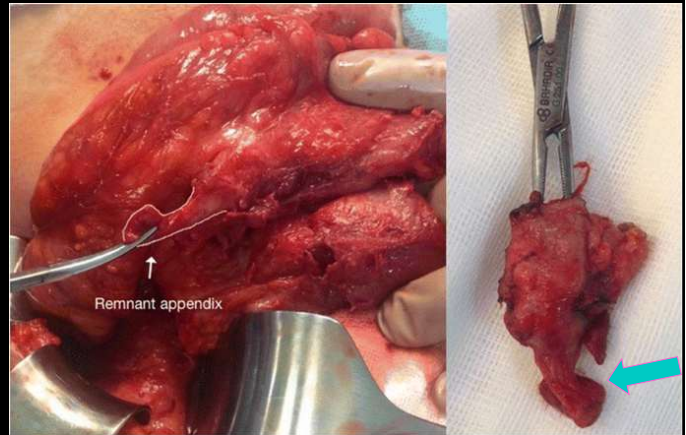
Images on file with author, Cielma T.

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## Case Report X

- Stump appendicitis is the inflammation of the residual appendiceal tissue **after** an appendectomy.
- It is rare ( 1:50,0000 )
- Occurs post-op – between 9 weeks and 50 years
- Retrocecal or subserosal appendix positioning can obscure complete removal.
- Appendiceal duplication (rare but reported cases with >5 cm residual stump).
- Surgical risk factors:
  - Inflamed appendiceal base can be misidentified intraoperatively, leaving residual stump.
  - Variable appendiceal length increases stump risk.

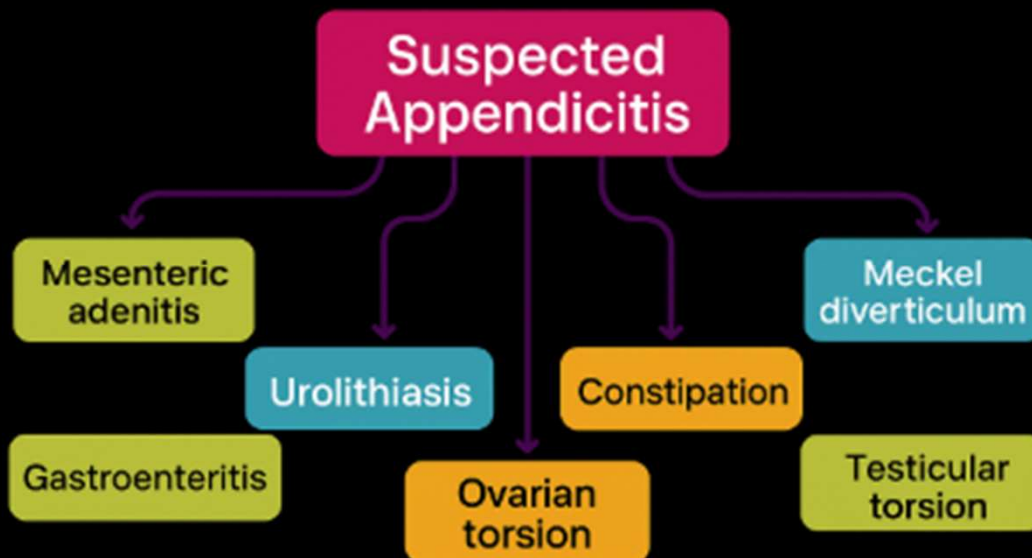
## Stump Appendicitis



O'Donnell ME, Sharif MA, O'Kane A, Spence RA. Stump appendicitis: a rare but important differential diagnosis of right iliac fossa pain. World J Emerg Surg. 2008;3:19. doi:10.1186/1749-7922-3-19.

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## Differential Diagnoses



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## Diagnostic & Supportive Procedures

### Surgical Intervention

- Surgical appendectomy remains the gold standard, especially in cases with perforation or appendicolith.
- Indicated if:
  - Clinical signs of appendicitis + imaging confirmation
  - Signs of perforation, abscess, or generalized peritonitis
  - Non-resolving appendiceal mass or phlegmon after conservative (antibiotic) management
- Procedures may include:
  - Laparoscopic appendectomy
  - Abscess drainage
  - Interval appendectomy (in delayed on non-operative management scenarios)



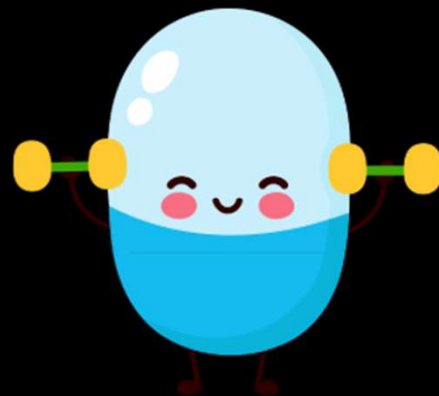
Science Photo Library. Appendix removal surgery. Science Photo Library website. Published 2016.

65

## Diagnostic & Supportive Procedures

### Medical Management

- Conservative management with antibiotics alone may be considered in selected, uncomplicated cases.
- Recurrence rates after nonoperative treatment are approximately 14–20% within 1 year.

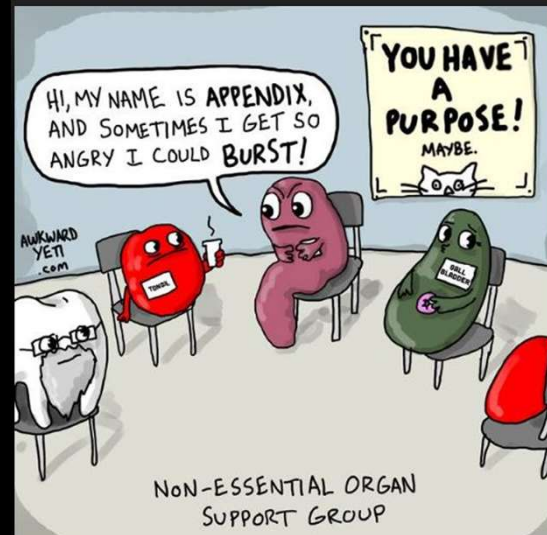


Science Photo Library. Appendix removal surgery. Science Photo Library website. Published 2016.

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## Take Home Points

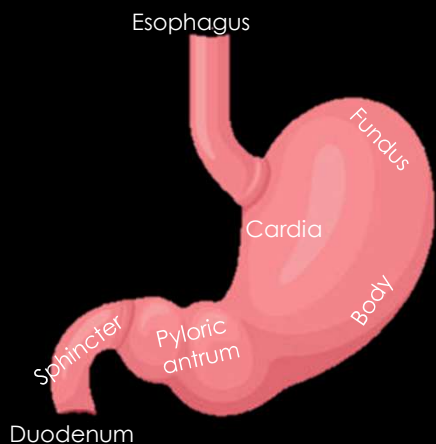
- Talk to your patient
- Survey carefully
- Remember that the appendix is **blind-ending**
- Ensure you **evaluate from origin/base to the tip** for assurance that you have correctly identified the appendix
- The appendix should be measured at its **maximum transverse diameter** from outer wall to outer wall (**serosa to serosa**)



The Awkward Yeti. Non-Essential Organ Support Group [cartoon]. The Awkward Yeti website. Published 2014. Accessed August 2, 2025. <https://theawkwardyeti.com/comic/non-essential-organ-support-group/>

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## Hypertrophic Pyloric Stenosis



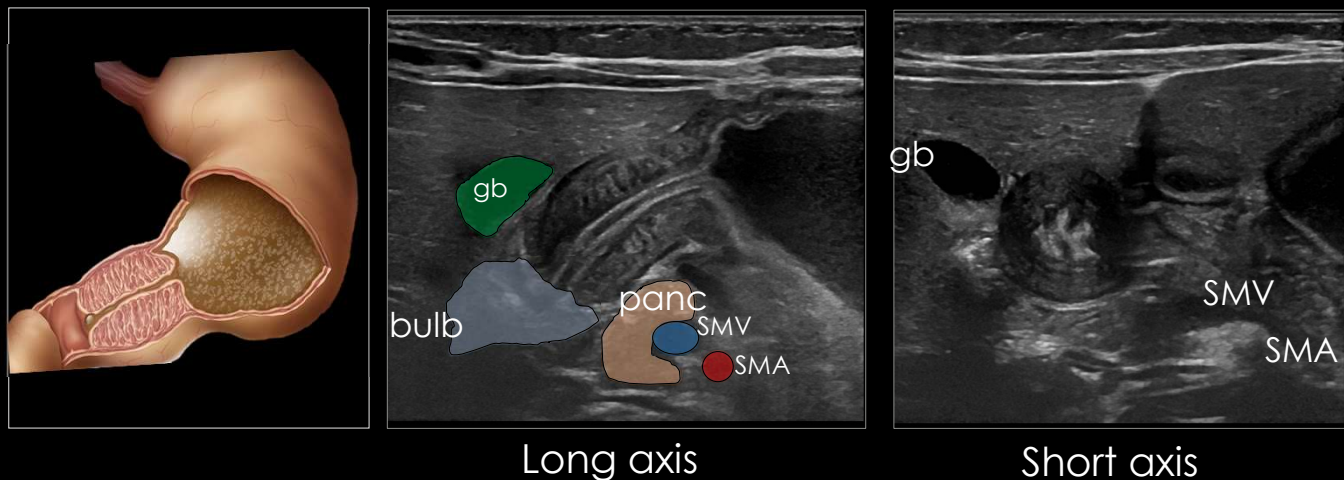
- Characterized by **abnormal thickening** of the antropyloric portion, resulting in **mechanical gastric obstruction**
- Develops **2-12 weeks** of life
- Peaks at **1 month** of age
- **Male** infants, especially **firstborns** and **Caucasians**, are at higher risk
- Early postnatal exposure to macrolide abx (eg **erythromycin**) have been linked to an increased risk
- Most common condition requiring surgery in infants

**Progressive gastric outlet obstruction > Gastric distension & retained stomach contents > Non-bilious projectile vomiting > Fluid & electrolyte loss (hypochloremia, hypokalemia) > Metabolic alkalosis > Dehydration > Failure to thrive & clinical deterioration**



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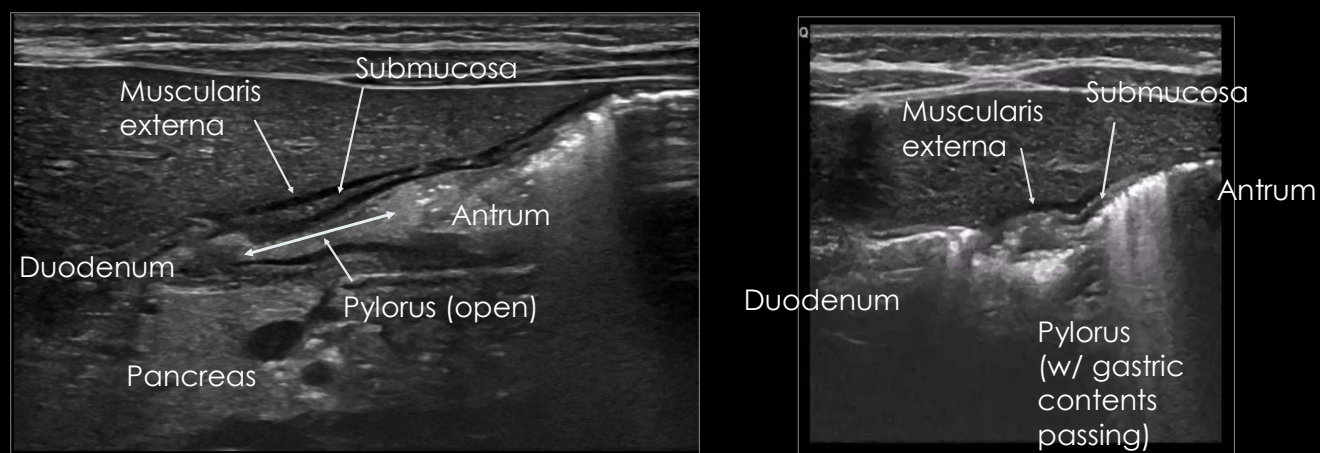
## Locating the Pylorus - Landmarks



Images on file with author, Cielma T.

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## Locating the Pylorus - Landmarks

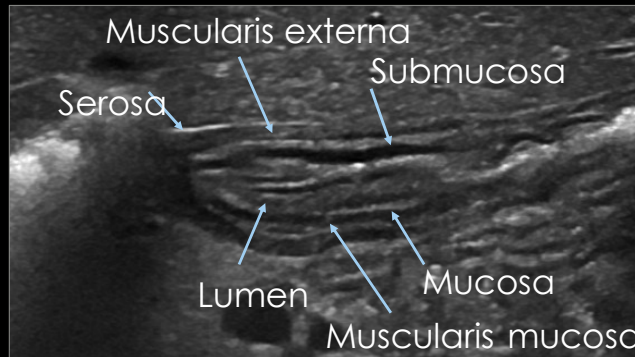


Normal

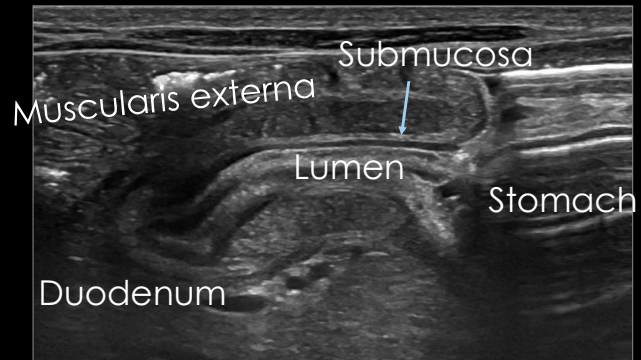
Images on file with author, Cielma T.

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## Locating the Pylorus



Normal



Abnormal

Images on file with author, Cielma T.

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## Diagnostic Criteria - Normal



Normal pyloric muscle:

- Measures **<3mm** thick

Normal pyloric channel:

- <15 mm** in length



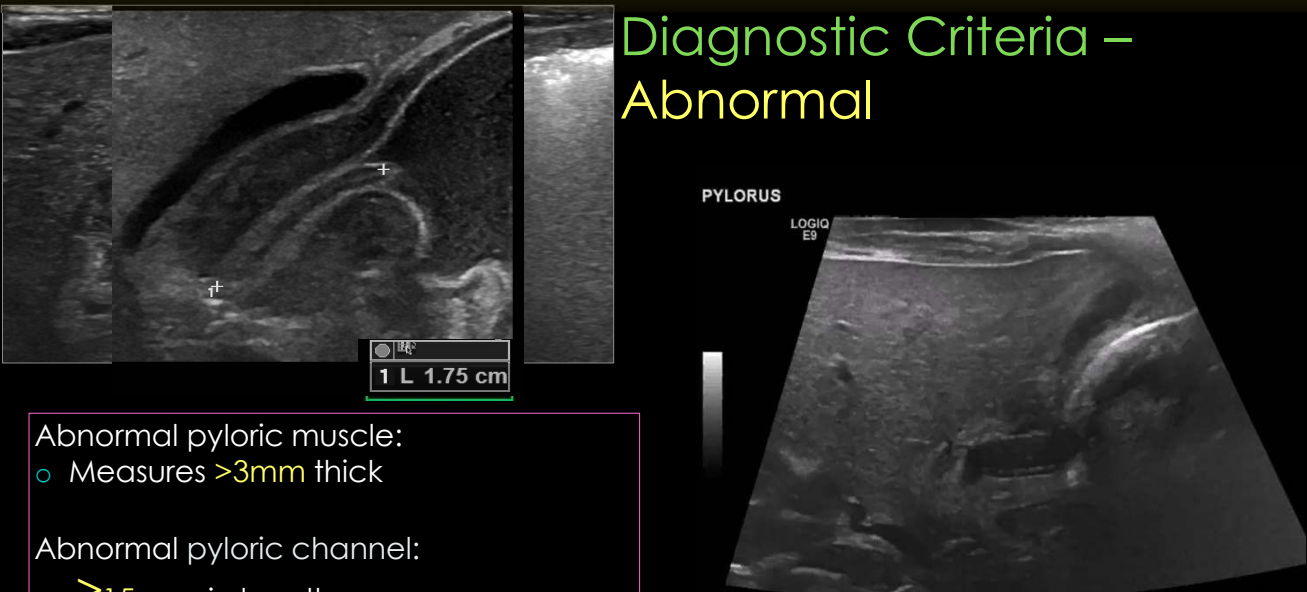
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## Diagnostic Criteria – Abnormal



Abnormal pyloric muscle:

- Measures **>3mm** thick

Abnormal pyloric channel:

- ≥15 mm** in length


Images on file with author, Cielma T.

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## Sonographic Signs – Target / Doughnut

Target/doughnut sign:

- Peripheral ring of hypertrophied hypoechoic muscle surrounding central echogenic mucosa, resembling a **doughnut**.



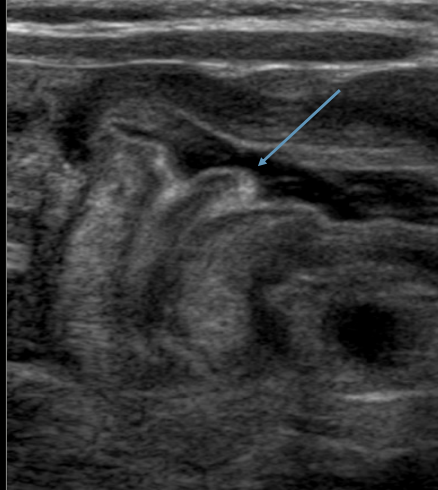
Images on file with author, Cielma T.

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## Sonographic Signs– Antral Nipple

### **Antral nipple** sign:

- Redundant pyloric mucosa protruding into the gastric antrum (arrow)



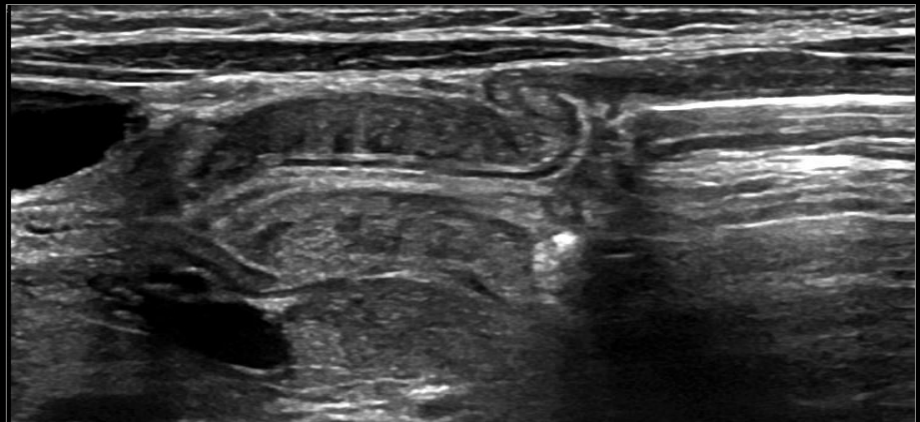
Images on file with author, Cielma T.

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## Sonographic Signs – Cervix

### **Cervix sign:**

- Extension of hypertrophied pyloric muscle into the antrum
- Elongated pyloric channel
- Form an image that resembles a cervix



Images on file with author, Cielma T.

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Let's measure up – pulse check

Trans



Long

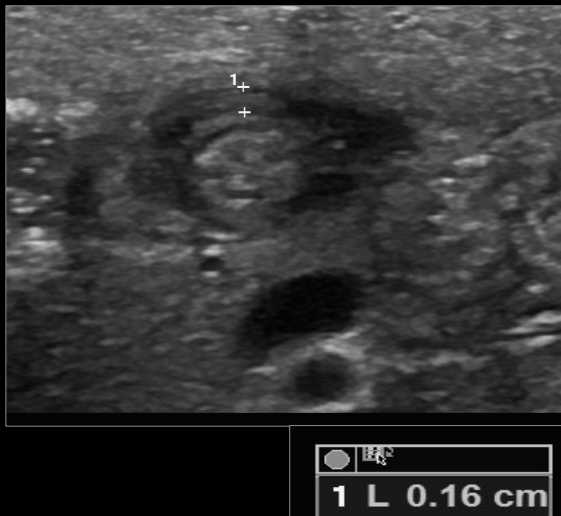


Images on file with author, Cielma T.

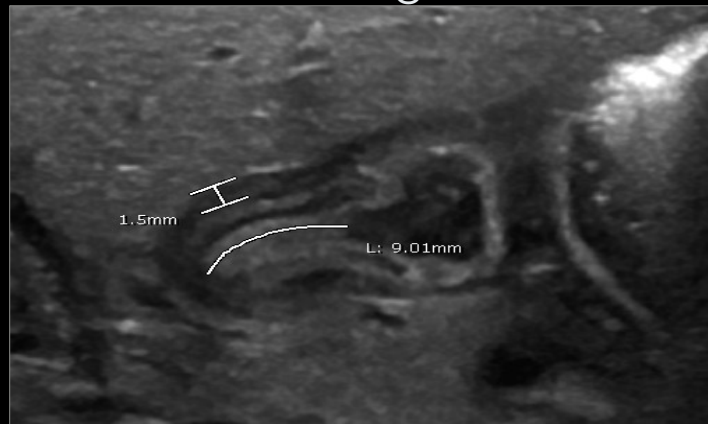
77

Let's measure up – pulse check

Trans



Long



Images on file with author, Cielma T.

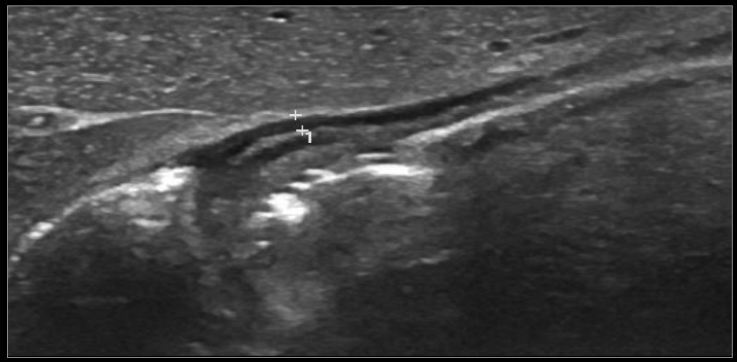
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# 2025 SDMS Annual Conference

Let's measure up – pulse check



0.31 cm

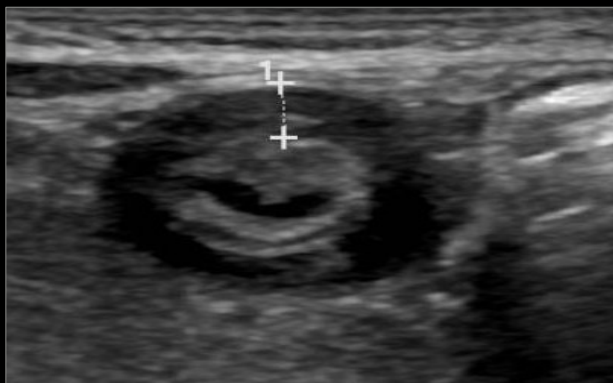


0.16 cm

Images on file with author, Cielma T.

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Let's measure up – pulse check



0.27 cm



0.13 cm

Images on file with author, Cielma T.

Optimize your image!

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## Pyloric Stenosis – Reality



- **ED or urgent outpatient exam**
- Baby hasn't fasted → recently fed + vomiting.
- Constant squirming/crying → limited still windows.
- "**Where even is the pylorus?**" → gas-filled stomach masks everything.
- Scan becomes "baby origami" → multiple repositioning attempts.
- YES! I got it (ultimately... GEJ)

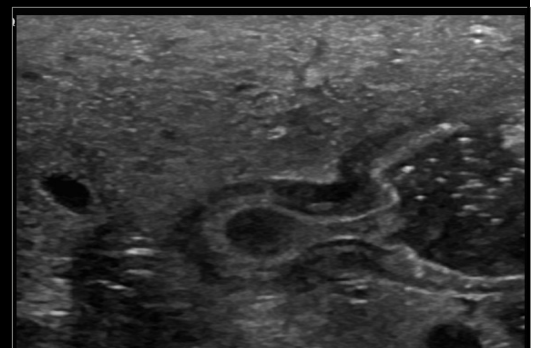
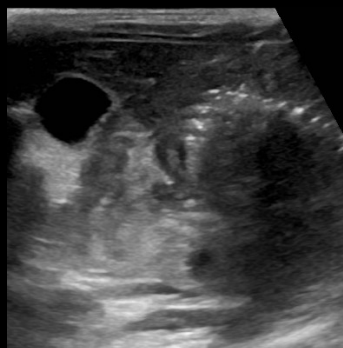
Sonographer's mantra: warm blankets, Sweet-Ease, a pacifier, warm gel and **persistence**

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## Potential Pitfall – Overlying Bowel

- RPO
  - Displaces gas, allows visualization of pylorus as fluid distends antrum
  - Improved acoustic window
- If empty, use non medicated liquid (like Sweet-Ease) to improve visualization of the pylorus
  - Intraoral
  - enteric tube



Images on file with author, Cielma T.

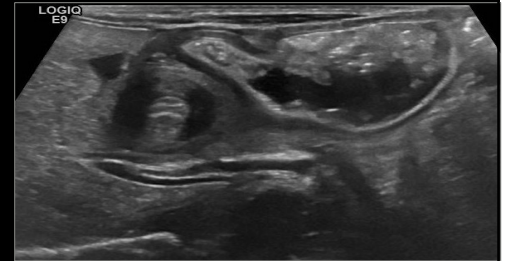
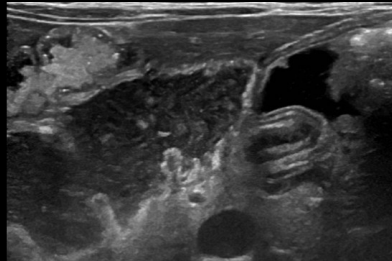
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## Potential Pitfall – Gastric overdistension

- Overdistension
- Gastric contents displace pylorus posteriorly
- Go lateral (flank approach)
- Alternate patient position from decub to supine



Images on file with author, Cielma T.

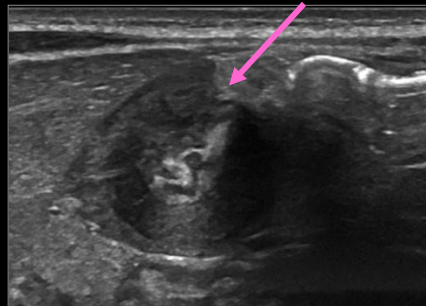
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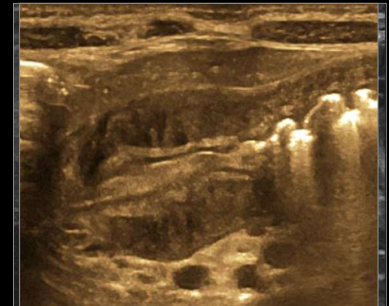
## Potential Pitfall – s/p pyloromyotomy (Ramstedt procedure)



Initial US



3 weeks post op



Post feed  
feed

Note: incision

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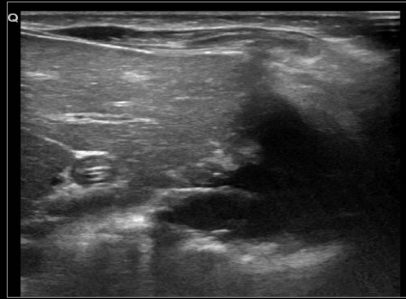
Patient is 3 weeks post-op

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## Potential Pitfall – GEJ



- GE Junction

- The gallbladder is located laterally.

- The gastric antrum lies proximally.

- The duodenal bulb is seen distally.

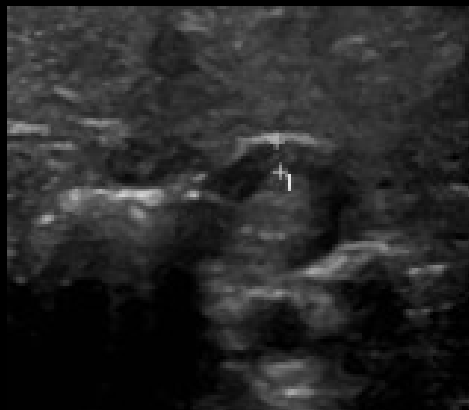
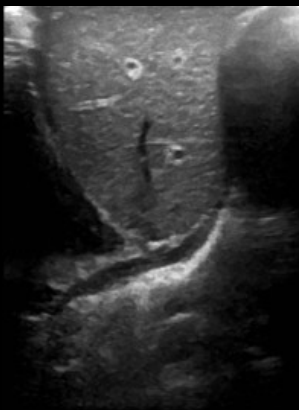
- In this case, the enteric tube passes through the gastroesophageal junction, confirming its identity.
- Always use anatomical landmarks to avoid misidentifying the pylorus during evaluation.

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## Potential Pitfall – GEJ



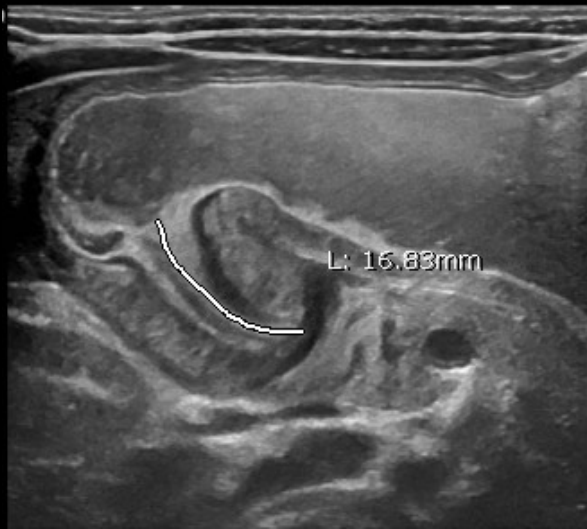
1 L 0.25 cm

- 2-month-old male with overdistended stomach from **breastfeeding** before ultrasound.
- Pyloric wall measured **0.25 cm**, within normal limits. **Contents appear to be passing actively.**
- However, **key landmarks** (gallbladder, duodenal bulb, pancreatic head) were **not visualized**.
- Sonographer was uncomfortable with exam due to obscuring gas and asked for a second look.

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- Increased pressure
- Alternate position

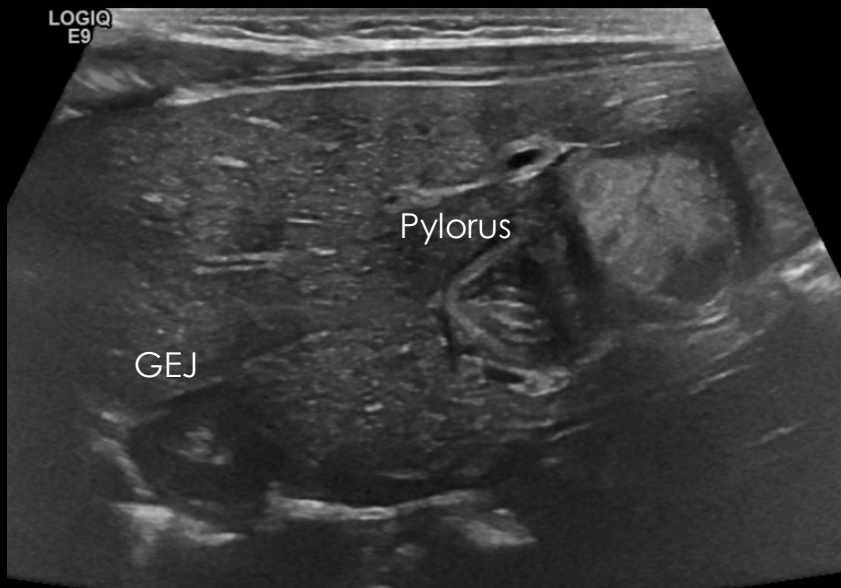
→ SMA / SMV now apparent in image

Images on file with author, Cielma T.

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- Fellow training → first lesson
- Accurate landmark identification is key to correct diagnosis.
- Prevents confusion between pylorus and nearby structures.
- Gallbladder, gastric antrum, and duodenal bulb are essential guides.
- Avoids misdiagnosis and unnecessary procedures.
- Scanning with landmarks improves diagnostic confidence.



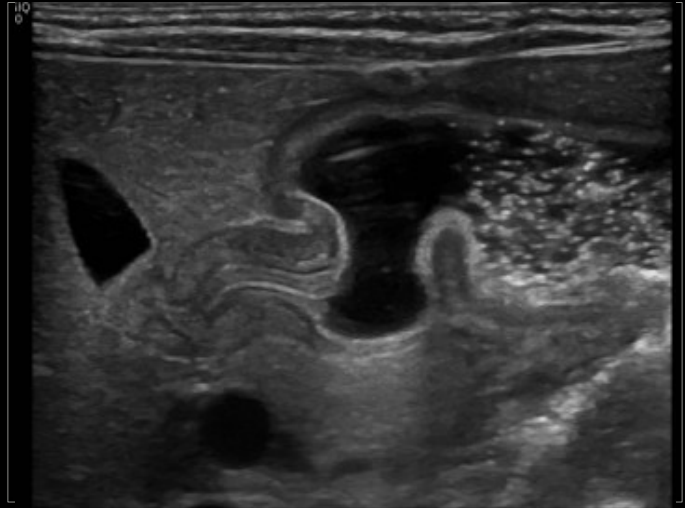
Images on file with author, Cielma T.

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## Potential Pitfall – Pylorospasm

- Pylorospasm is a **transient** cause of **delayed gastric emptying**.
- It can closely **mimic** pyloric stenosis on ultrasound.
- Unlike true stenosis, pylorospasm **resolves spontaneously**.
- **Wait several minutes** (we would scan another patient and reassess.)
- **Reposition** the patient if needed.
- **Repeat imaging** to check if muscle thickening **persists or resolves**.



Images on file with author, Cielma T.

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## Diagnostic & Supportive Procedures

### Ramstedt Procedure (pyloromyotomy)

- Conservative management with antibiotics alone may be considered in **selected, uncomplicated cases**.
- **Recurrence rates** after nonoperative treatment are approximately **14–20%** within 1 year.



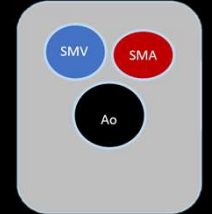
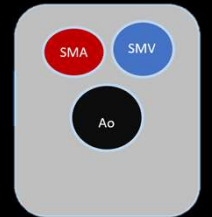
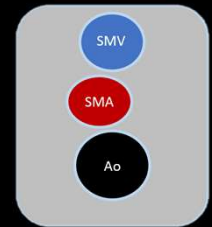
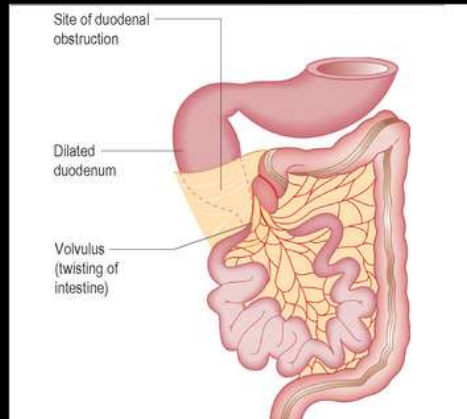
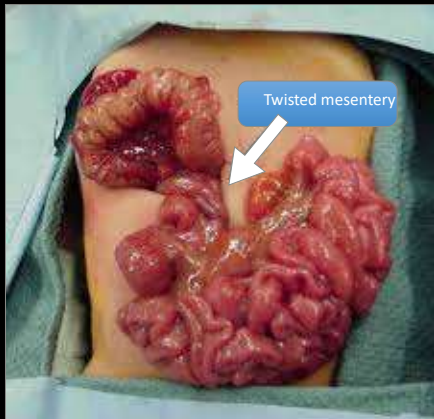
Fredet R, Ramstedt C. Pyloromyotomy technique illustration. ResearchGate. Published 2023. Available from: [https://www.researchgate.net/figure/Fredet-Ramstedt-pyloromyotomy\\_fig4\\_384080130](https://www.researchgate.net/figure/Fredet-Ramstedt-pyloromyotomy_fig4_384080130)

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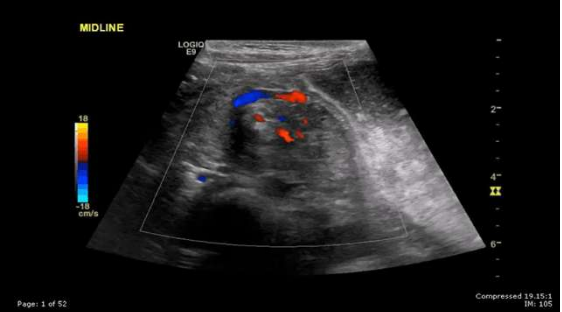
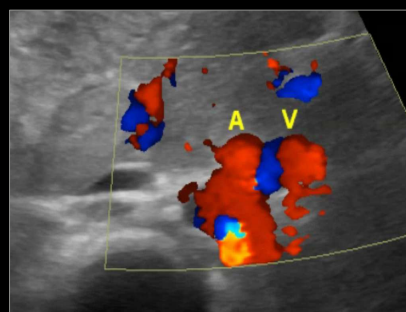
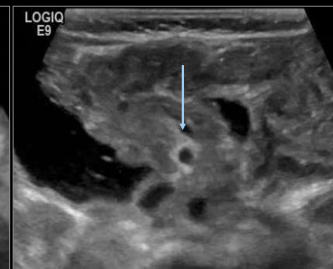
## Differential: Malro & Volvulus



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## Malrotation with Volvulus

- Two-year-old male p/w bilious vomiting and intermittent abdominal pain. Pyloric stenosis ruled out.
- Abnormal **clockwise swirling** of mesenteric vessels in midline abdomen—"whirlpool sign."
- Thickened loop of small bowel and mesentery c/w volvulus.
- LPO radiograph reveals **abnormal course of duodenum and jejunum** with low-positioned ligament of Treitz (normally at duodenal bulb)
- Early diagnosis is critical to prevent bowel ischemia, necrosis, and need for resection.**



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## Necrotizing Enterocolitis (NEC)

- Necrotizing enterocolitis is an inflammatory condition resulting in bowel wall necrosis, predominantly affecting premature neonates.
- It is the most common gastrointestinal emergency in the NICU, with an incidence of 5–10% among very low birth weight infants (<1500g).
- The mortality rate ranges from 15–30%, increasing significantly in cases requiring surgery.



Langer JC. Intussusception: Current Concepts in Diagnosis and Treatment. Semin Pediatr Surg. 2018;27(3):161–165. doi:10.1053/j.sempedsurg.2018.05.004

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## NEC

### Initial evaluation:

- Abdominal x-ray is the first-line screening tool for NEC.
- Look for bowel distention and abnormal gas patterns.
- Radiographs are fast and widely available but may miss early or subtle disease.

### Role of Ultrasound:

- Used to clarify ambiguous X-ray findings or assess clinical deterioration.
- Detects bowel wall changes: thickening, thinning, pneumatosis, free fluid.
- More sensitive for portal venous gas. Doppler imaging evaluates real-time bowel perfusion and viability.

### Major Risk Factors:

- Prematurity and LBW (<1500g).
- Enteral feeding, especially formula feeding.
- Immature gut barrier and heightened inflammatory response in preemies.
- Additional contributors: sepsis, patent ductus arteriosus, abnormal gut colonization.

Langer JC. Intussusception: Current Concepts in Diagnosis and Treatment. Semin Pediatr Surg. 2018;27(3):161–165. doi:10.1053/j.sempedsurg.2018.05.004

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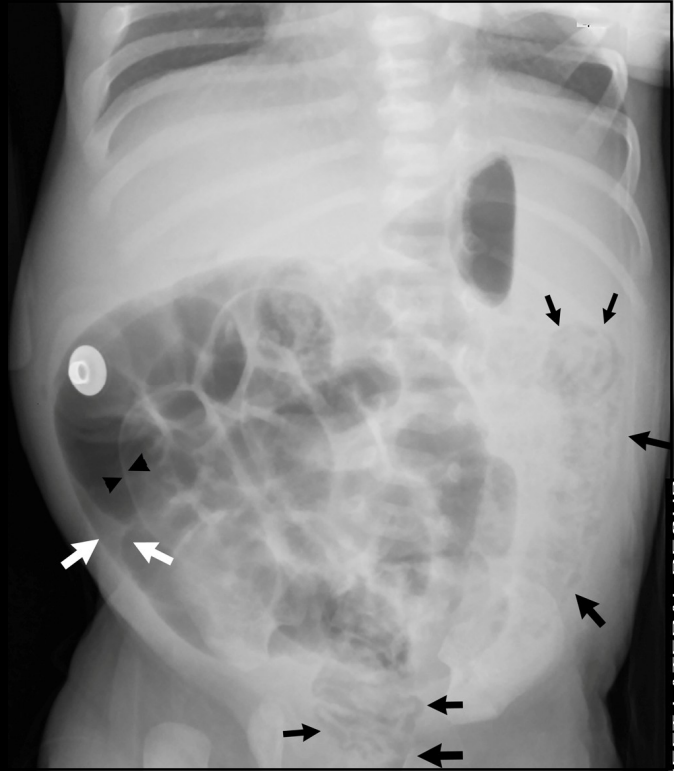
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## NEC

### Clinical Presentation:

- Abdominal distention
- Blood-streaked stools
- Feeding intolerance
- Increased gastric residuals
- Systemic signs:
  - apnea
  - bradycardia
  - lethargy
  - temperature instability

Rumbly in the Tummy: Pneumatosis Intestinalis and Necrotizing Enterocolitis. RadiologyKey. Published 2023. Accessed August 5, 2025.  
<https://radiologykey.com/rumbly-in-the-tummy-pneumatosis-intestinalis-and-necrotizing-enterocolitis-2/>

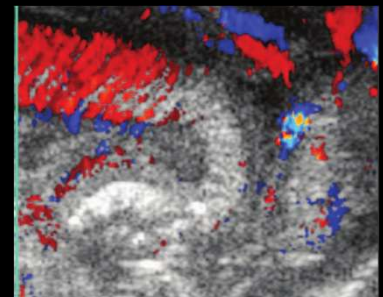
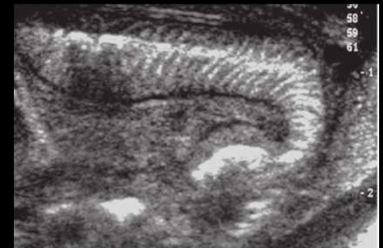


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## NEC

### Imaging Technique:

- Assess bowel wall thickness and echogenicity:  
Thickening ( $> 2.6$  mm) is a key early indicator
- Zebra pattern: Represents thickened, hyperechoic valvulae conniventes.
- Evaluate bowel peristalsis: Decreased or absent peristalsis suggests intestinal compromise.
- Detect pneumatosis intestinalis: Intramural gas appears as hyperechoic spots.



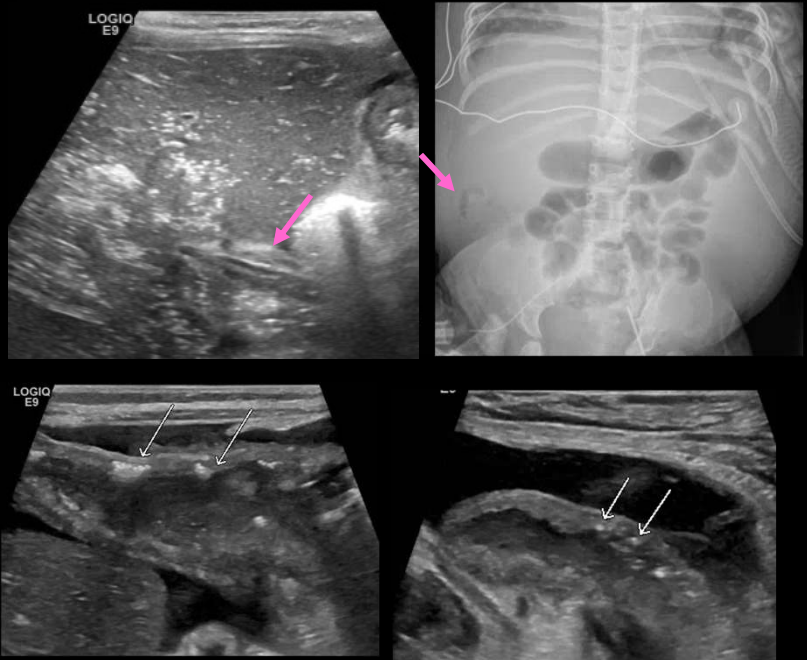
The role of ultrasound in necrotizing enterocolitis - Scientific Figure on ResearchGate. Available from: [https://www.researchgate.net/figure/Zebra-stripes-sign-in-an-8-month-old-girl-born-at-26weeks-of-gestation-with-VACTERL\\_fig8\\_355350999](https://www.researchgate.net/figure/Zebra-stripes-sign-in-an-8-month-old-girl-born-at-26weeks-of-gestation-with-VACTERL_fig8_355350999)

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## NEC

- 7-month-old female, s/p BMT
- Ultrasound revealed
  - extensive portal venous gas
  - multiple bright foci in bowel wall
  - diffuse bowel wall edema
  - ascites

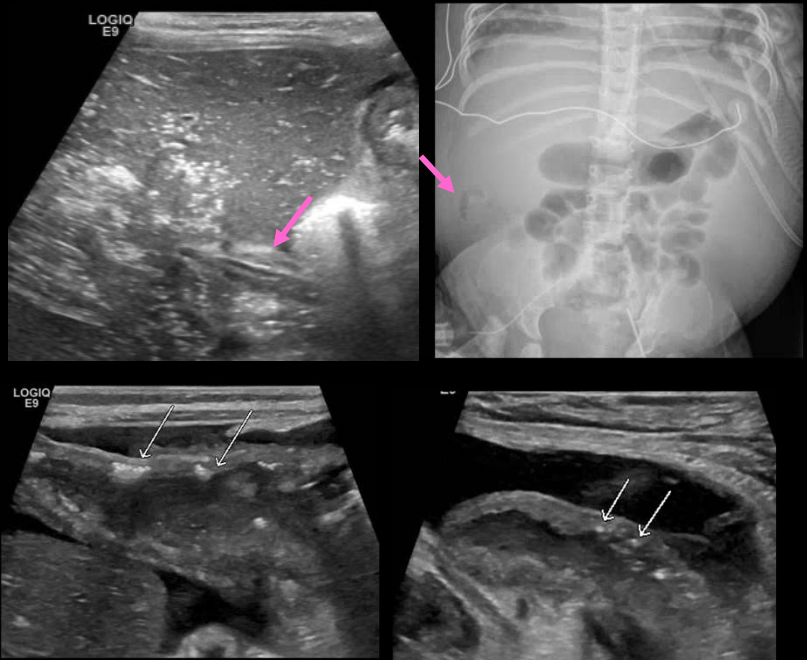


Images on file with author, Cielma T.

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## NEC

- Pneumatosis intestinalis appears as small echogenic foci within the **nondependent** bowel wall — often detectable earlier than on X-ray.
- Portal venous gas is visible as bright echogenic dots within the **liver** and **PVs**.
- Other sonographic signs include:
  - Diffuse bowel wall **edema** and **thickening**
  - **Absence** of peristalsis
  - Echogenic or complex FF
  - **Fixed, dilated** loops
  - Reduced wall stratification, indicating advanced disease



Images on file with author, Cielma T.

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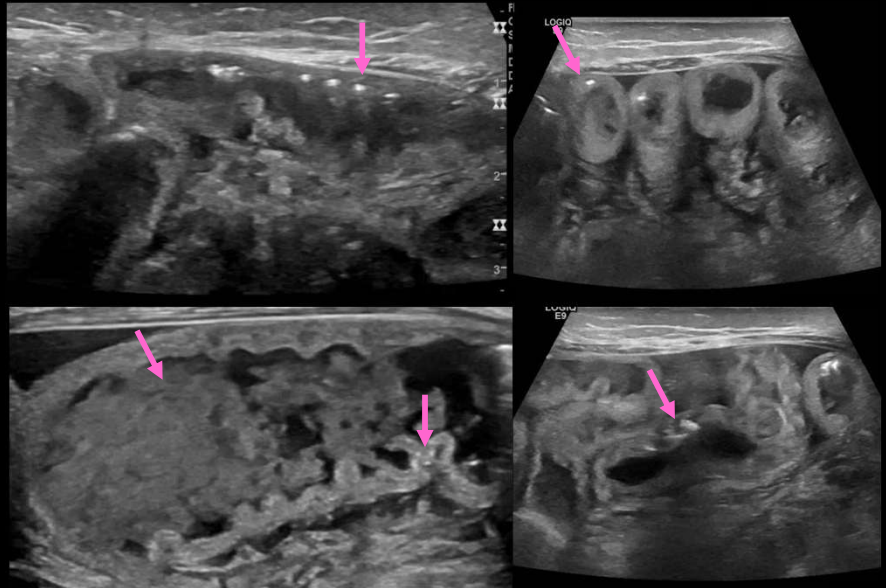


## Bowel Ischemia & Pneumatosis

6-month-old ex-premature female with prior volvulus and bowel resection now p/w diarrhea and hypovolemic shock

- Diffuse bowel wall edema with concentric thickening (indicates severe enterocolitis or ischemia)
- Echogenic foci within bowel wall consistent with pneumatosis intestinalis
- Echogenic material within bowel lumen suggesting hemorrhage

Images on file with author, Cielma T.



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## NEC – Staging & Progression

- **Stage I (Suspected NEC):**
  - Nonspecific signs: abdominal distension, mild feeding intolerance, apnea, lethargy, temperature instability.
  - Possible mild radiographic changes like intestinal dilation or mild ileus.
- **Stage II (Confirmed NEC):**
  - Radiographic evidence of pneumatosis intestinalis (intramural gas) and/or portal venous gas.
  - Clinical signs of sepsis or systemic inflammatory response.
- **Stage III (Advanced NEC):**
  - Severe systemic illness, signs of intestinal perforation (pneumoperitoneum).
  - Peritonitis and shock may be present.



National Birth Injury Law. Necrotizing enterocolitis (NEC). Accessed August 5, 2025. <https://www.nationalbirthinjurylaw.com/necrotizing-enterocolitis>

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## Diagnostic & Supportive Procedures

### Treatment

- Medical treatment includes bowel rest, nasogastric decompression, broad-spectrum antibiotics, and close monitoring.
- Surgery is indicated in cases of perforation, necrosis, or failure of medical therapy, often requiring resection or ostomy creation.
- Amniotic fluid stem cells → novel therapeutic option showing promise in preclinical models
- Early sonographic identification of high-risk features may expedite surgical consultation and improve outcomes.



Science Photo Library. Appendix removal surgery. Science Photo Library website. Published 2016.

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## Pediatric Differential Diagnoses

- Pediatric abdominal complaints often overlap, requiring differentiation between multiple high-risk conditions.
- For example, vomiting may indicate pyloric stenosis, NEC, or malrotation, while RLQ pain could suggest appendicitis, gonadal torsion, urolithiasis or mesenteric adenitis.
- Comparing hallmark signs helps refine the diagnosis and prioritize imaging.

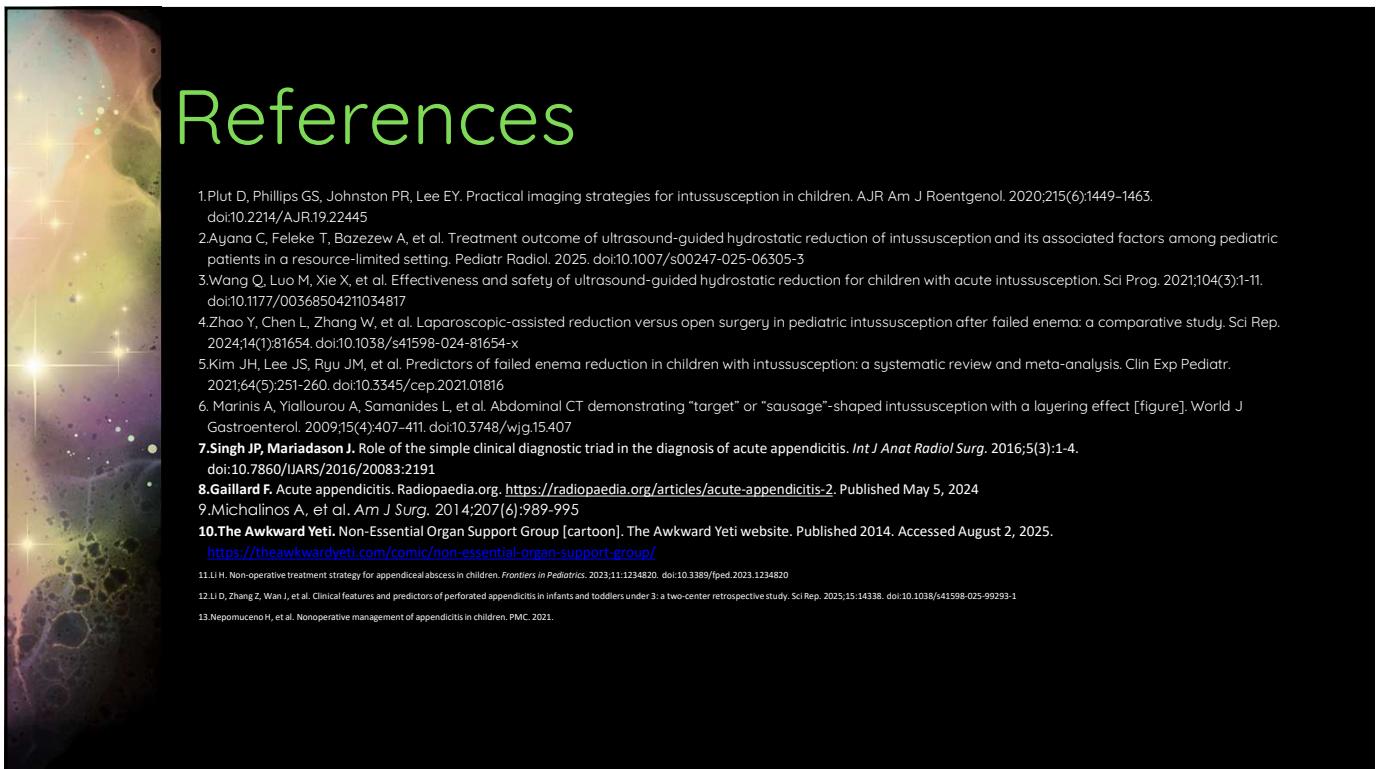


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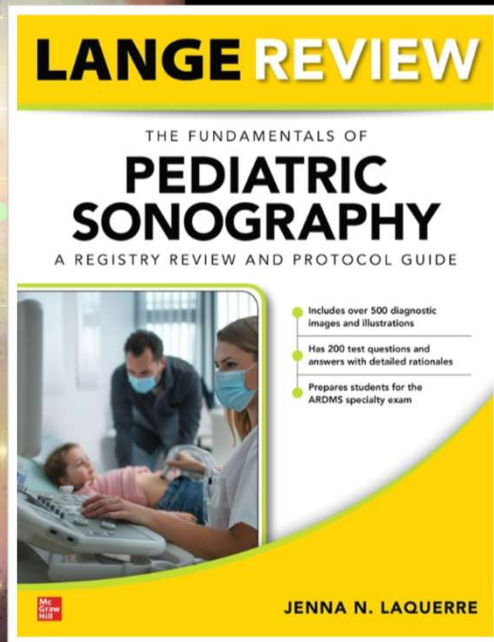


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Drum  
roll... it's  
raffle  
time!