RUTGERS
School of Nursing

A Virtual Lecture with Hands-on Simulation of the Gastric Ultrasound Examination

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Please take a moment to fill out a

Pre-Intervention Test

found at the link below

https://rutgers.ca1.qualtrics.com/jfe/form/SV_88oXUbQ3wCRpyh7

Aims & Objectives

- To increase the anesthesia provider's confidence in the identification of the gastric antrum's contents with point-of-care gastric ultrasound
- To increase the anesthesia provider's competency in the identification of the gastric antrum's contents with point-of-care gastric ultrasound
  - To create a forum that addresses the evidence, indications, benefits, use, and interpretation of gastric ultrasound.
  - To provide examples of various prandial statuses with gastric ultrasound photos and videos.
  - To provide a hands-on demonstration of gastric ultrasound and the various prandial status' that can be encountered.
  - To disseminate an evidence-based decision tree to aid in data interpretation of the gastric ultrasound results to encourage use in the clinical setting and promote longevity of the training.

Significance

Pulmonary Aspiration is An Anesthesia-Related Complication

- Incidence varies between <0.1% and 19%
  - 1 in every 2 – 4,000 operations
- Significant perioperative morbidity and mortality
  - Mortality: 5%
  - 9% of all anesthesia-related deaths
- Single case of aspiration pneumonia costs: $30,280

Assessing a patient's aspiration risk is paramount for anesthesia providers

Background

- Classically, prevention strategies rely on asking last time patient ate and following fasting guidelines
- Current Assessment Tool: ASA NPO Guidelines is antiquated and has several shortcomings
  - Does not take into account a variety of patient factors:
    - Emergent and urgent surgeries
    - Communication and comprehension issues (LOC, AMS, drugs, language barrier)
    - Cognitive impairment
    - Pediatric population
    - Patient's may not be truthful
    - Medical conditions that delay gastric emptying

A New Way to Evaluate a Patient's Aspiration Risk

- Point-of-Care Gastric Ultrasound helps determine the volume and gastric content material in the patient's stomach
- Gastric ultrasound is:
  - **Simple**: Findings are easily recognizable & scanning technique can be quickly learned and performed
  - **Fast**: Takes less than 5 minutes
  - **Non-invasive**
  - **Accurate & Reliable**: Provides diagnostic data (qualitative and quantitative), high specificity and sensitivity
  - **Point-of-Care**: Performed at bedside, Focused/Limited in scope
  - **Real-time**

Helps anesthesia providers answer the question on whether the patient is at risk for pulmonary aspiration

Evidence: Validity, Reliability, and Interpretability of Gastric Ultrasound

Study	Findings
Jacoby et al. (2003)	Prediction of prandial status was highly sensitive (86%) and specific (70%).
Koenig et al. (2011)	Gastric ultrasound only took two minutes to complete. All patients were successfully intubated without any aspiration complications.
Kruisselbrink et al. (2019)	With a pretest probability of 50%, a positive test result increases the probability of a full stomach to 97%. A negative test result decreases the probability of a full stomach to less than 0.1%.
Perlas et al. (2011)	Anesthesiologists were able to correctly classify patients as grade zero or one 96.5% of the time. Only 3.5% were classified as a grade two and contained a larger than predicted gastric fluid volume than the other groups.
Fujigaki et al. (1993)	CSA significantly decreased as fasting time was prolonged. Antral CSA is dynamic and correlates with a prolonged fasting time.
Perlas et al. (2009)	Close-to- linear relationship between gastric volume and CSA in volumes up to 300 milliliters.
Bouvet et al. (2009)	Antral CSA was significantly smaller in fasting volunteers. Receiver operating characteristic curves showed an excellent performance of antral CSA's ability to distinguish a fasting stomach from a full stomach (AUC = .93).
Bouvet et al. (2011)	Antral CSA increased proportionally to the aspirated volume of gastric content up to 250 milliliters with a correlation coefficient of 0.72.
Perlas et al. (2013)	Mathematical model demonstrated a concordance correlation coefficient was 0.82 and the Pearson's correlation coefficient was 0.86.
Kruisselbrink et al. (2014)	Ultrasound assessment of gastric volume is highly reproducible. Intraraterreliability was nearly perfect for all three sonographers with intraclass correlation coefficients of 0.96 to 0.99.

Evidence: Impact and Benefits of Gastric Ultrasound in Changing Anesthetic Management

Study	Findings
Van de Putte (2013), Tampo et al. (2013), & Falvar and Kantzavelos (2018)	Gastric ultrasound afforded better guidance and tailored anesthetic management to the individual patient's situation.
Gaqey et al. (2016)	31 Infants undergoing pyloromyotomy, 30 (88.2%) where empty stomach was determined to perform a non-RSI. No complications were noted.
Alakkad et al. (2015)	Led to a change in some aspect of anesthetic management in twenty-seven (71%) of cases.
Van de Putte et al. (2018)	Anesthetic management changed in twenty-four (64.9%) of cases following gastric ultrasound with a lower number of surgical cancellations.
Gaqey et al. (2017)	Anesthetic induction plan changed in sixty-seven (47%) of children.

Limitations and Barriers

- Inaccurate in abnormal underlying gastric anatomy
  - Previous gastric resection/bypass gastric band
  - Fundoplication
  - Large hiatus hernia
- Antrum difficult to find/assess in 2-3% of normal individuals
- Challenges with:
  - Morbid obesity: older machines may not have adequate depth
  - Pregnancy: antrum may be displaced deep to the liver
  - Unable to position patients in RLD position

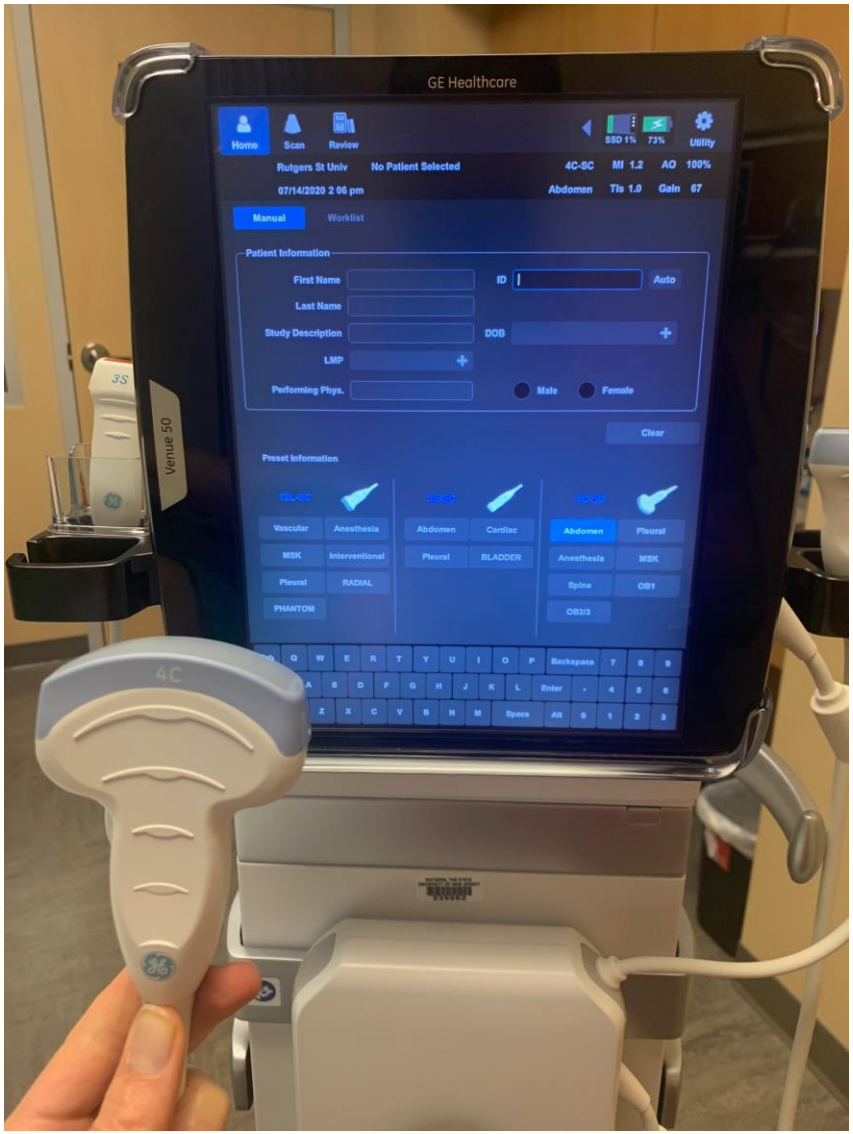
Indications

- Lack of adherence to fasting instructions
  - Emergency or Urgent procedure (no planned fasting)
  - Miscommunication
  - Questionable/Borderline adherence to fasting instructions
- Inability to obtain fasting history
  - Depressed level of consciousness
  - Language barrier
  - Cognitive dysfunction
- Co-morbidities that delay gastric emptying
  - Pregnancy/Active labor
  - Diabetes
  - Severe liver or kidney dysfunction
  - Neuromuscular disorders
  - Recent trauma
  - Pain and chronic opioid use
  - Gastric dysmotility

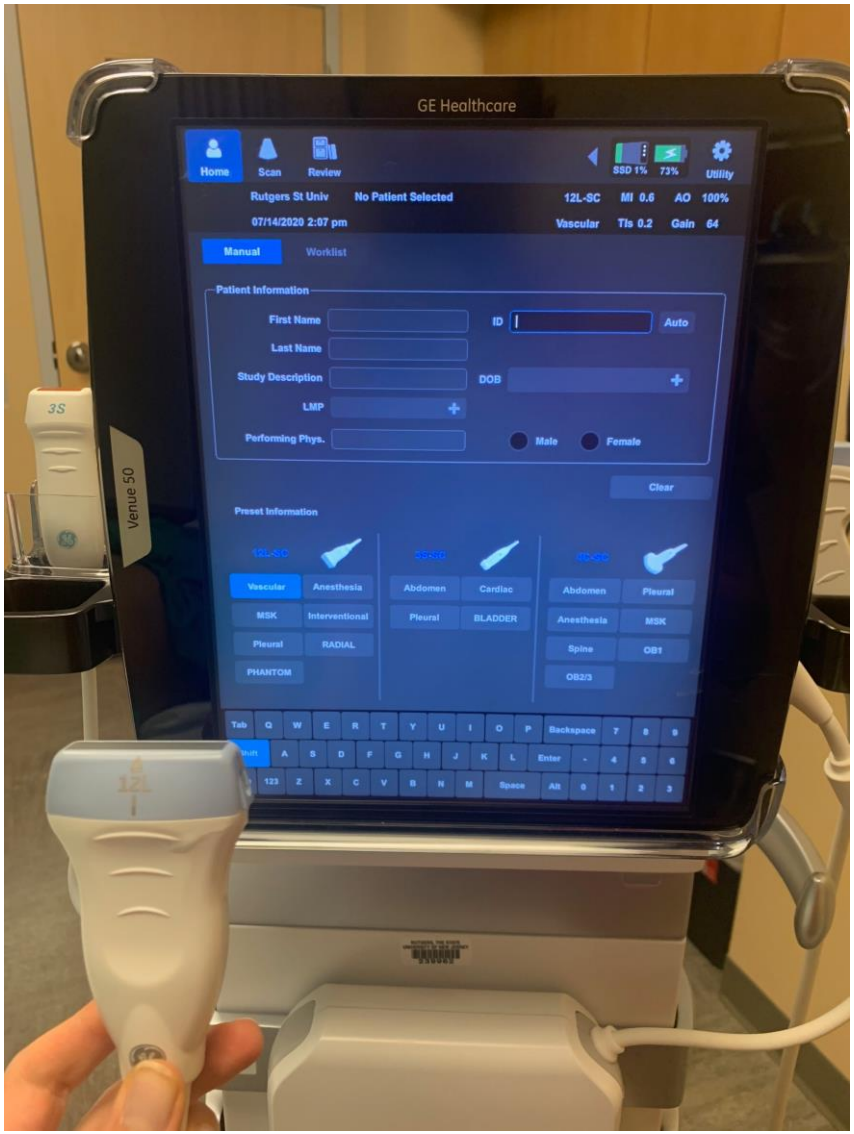
Performing the Scan

- Equipment
  - Ultrasound
  - **Adults**: Curvilinear, low-frequency (2-5MHz) transducer, abdominal setting
  - **Children/<40kg**: Linear, High frequency (8-13MHz) transducer, vascular setting
- Positions
  - Supine
  - Right Lateral Decubitus (RLD) position
- Position Takeaways
  - RLD is the best for interpretation
    - Gastric contents gravitate down to the antrum
    - Air migrates up to body of stomach
  - Supine alone is an incomplete scan
    - Underestimates the amount of gastric content

Curvilinear Probe, Abdominal Setting



Linear Probe, Vascular Setting



Performing the Scan:
Steps: Scanning Technique

Start supine:

1. Probe indicator towards the head
2. Place probe just below xiphoid process
3. Sagittal plane (Runs mouth to tail)
4. Sweep transducer left to right along subcostal margin
5. Identify gastric antrum using standard anatomical landmarks
   - Interpret scans between contractions or when antrum relaxed
6. Position to right lateral decubitus

Repeat steps in right lateral decubitus position

Supine

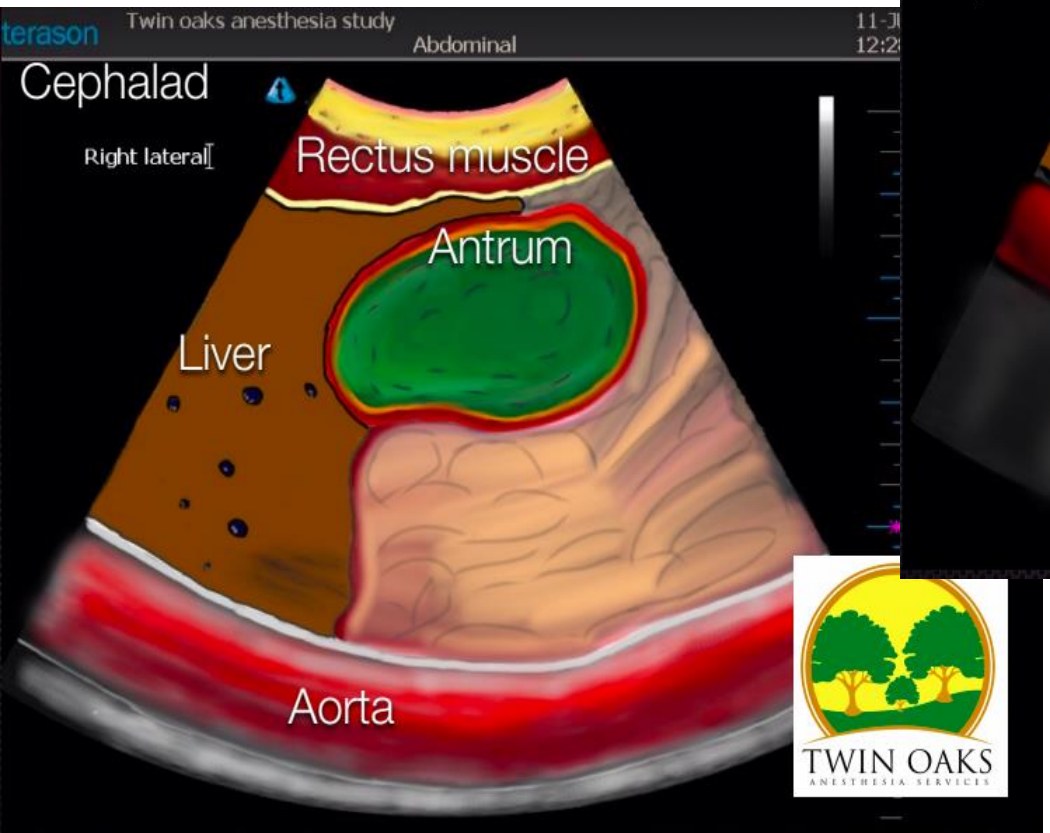
Right Lateral Decubitus

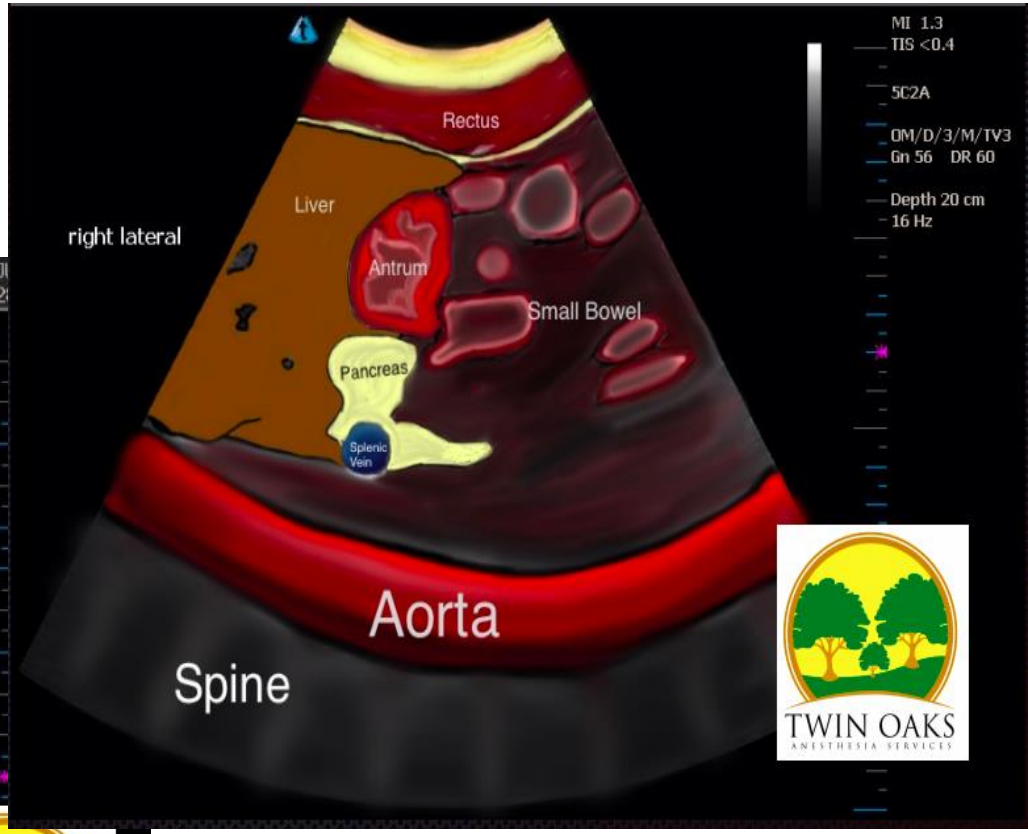
Performing the scan: Anatomy

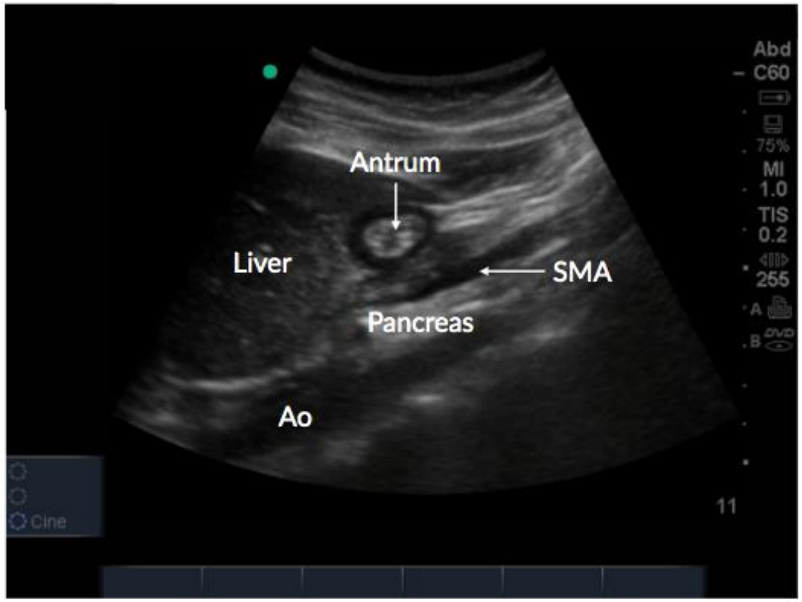
- Stomach has 3 anatomical parts:
  1. Fundus- superiorly located
  2. Body- most of the mass
  3. Antrum- inferiorly located, prior to pyloric sphincter: where the exam is focused on
- Gastric Antrum
  - Primary area of interest in assessing gastric contents
  - Holds food until released to small intestine
  - Consistently located in epigastrium
  - Most amendable to examination
  - Accurately reflects the content of the entire stomach
  - Less air content that interferes with scan
  - Usually 3-4cm deep

Landmarks on Ultrasound

- Inferior/Posterior to left lobe of the liver (usually at 9 o'clock)
- Anterior to pancreas
- Anterior to Aorta/IVC






Antrum
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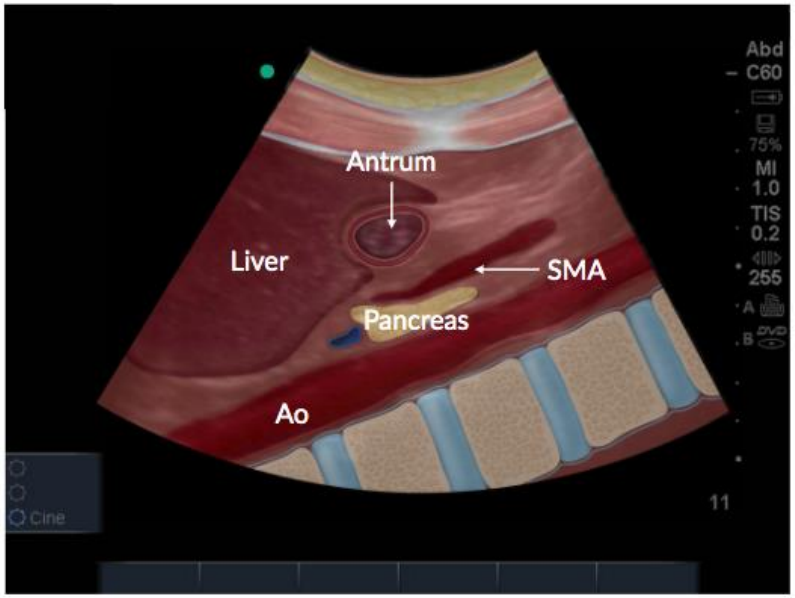
Antrum
Liver
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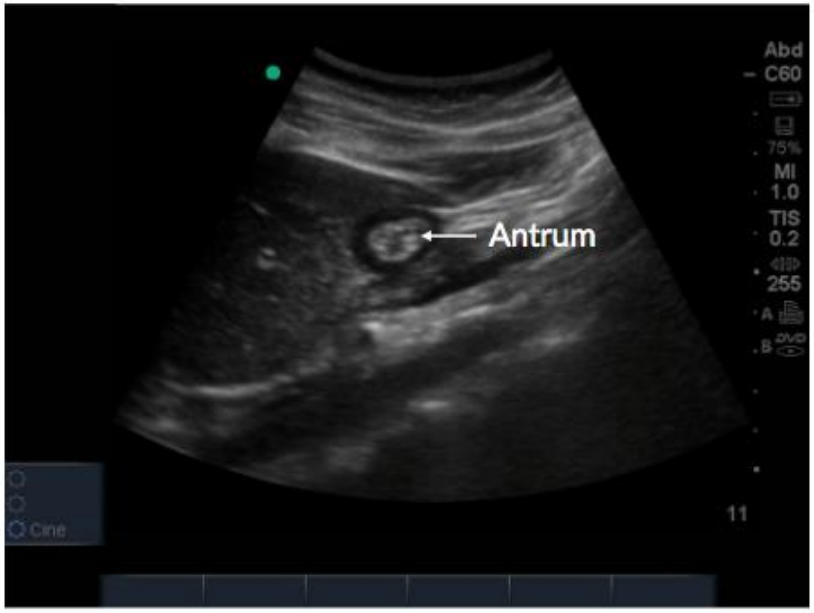
Types of Gastric Content

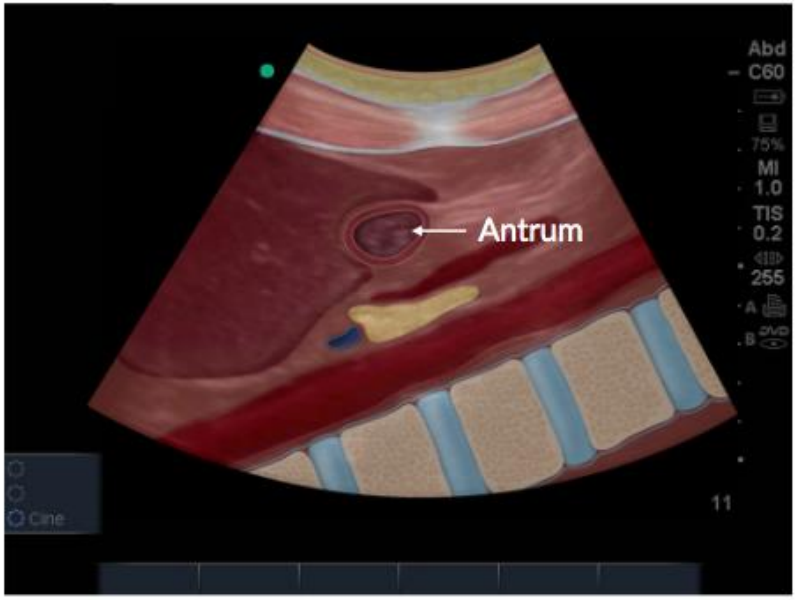
- Empty
- Solid
- Milk/Suspensions
- Clear Fluid

Empty

- No content in both supine and RLD
- Antrum flat & collapsed
- Small, 2-3cm in diameter
- Round, Ovoid shape
- “Bulls eye” or “Target”
- Ring is thick muscularis propriae

Empty Antrum

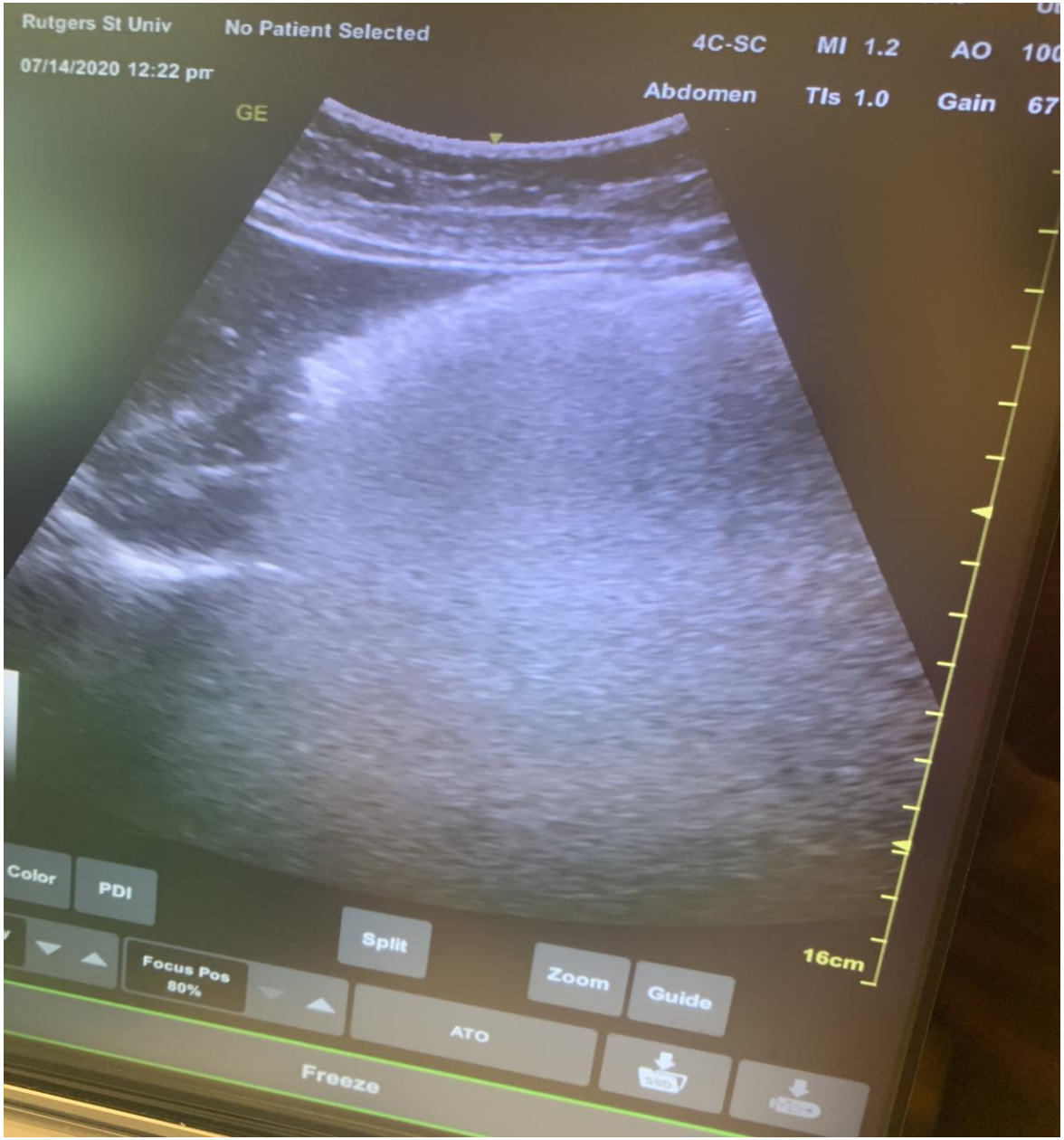




Solid

- Antrum distended
- Thin muscle wall

- Early
  - Contents of high/mixed echogenicity
  - “Frosted glass”
    - Mixing of air and solid along anterior wall
    - Blurring of posterior wall and deeper structures
- Late (1-2 hours following a solid meal)
  - Heterogeneous, particulate content
    - Solid food
  - Homogenous, hyperechoic content
    - Characteristic of dairy products or particulate fluids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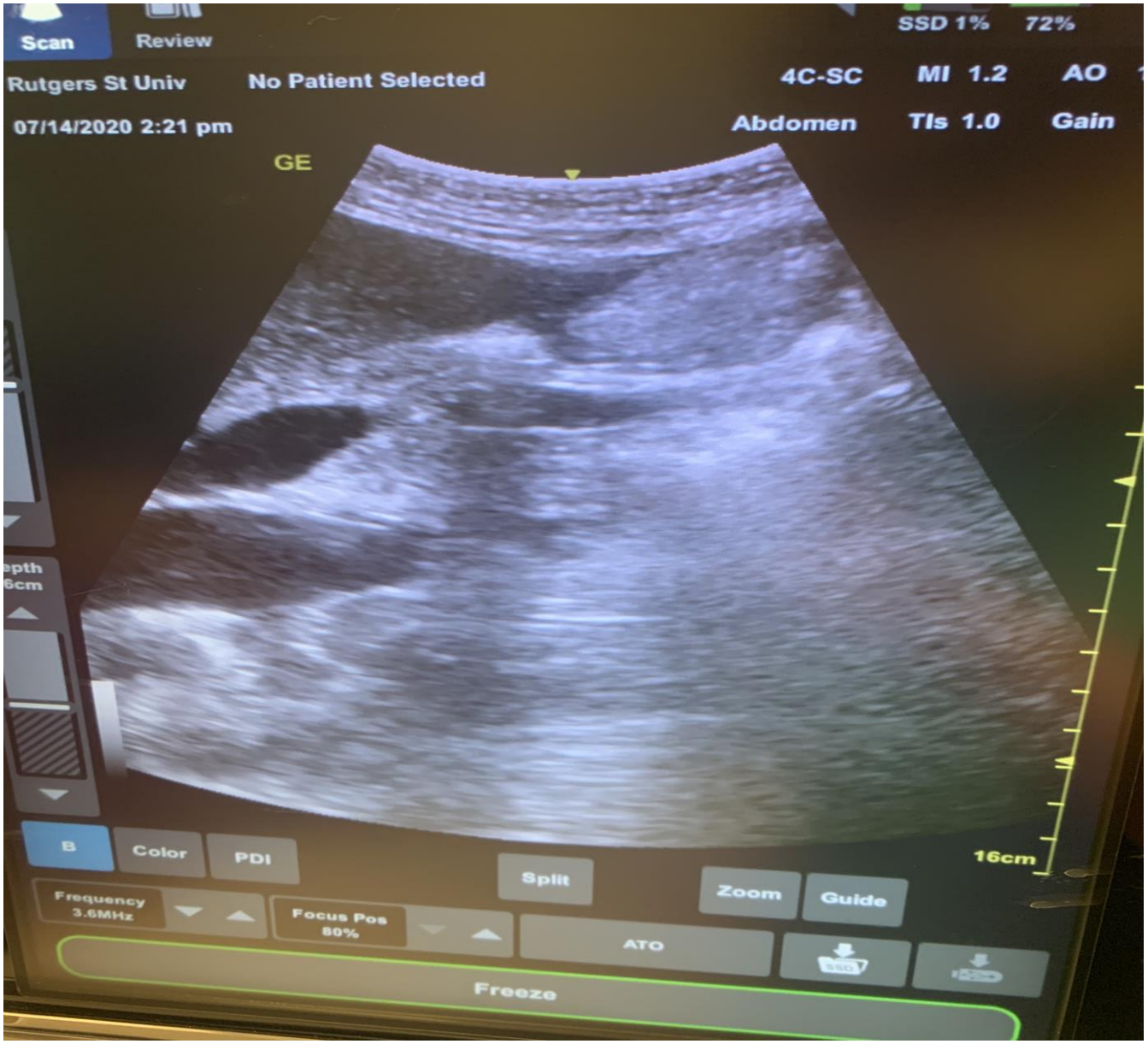
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Fluid

- Liquids are anechoic or hypoechoic
  - All fluids have similar appearance (gastric secretions to clear fluids e.g., water, tea, apple juice)
- Antrum round & distended
- Thin muscular wall
- Size of antrum is proportional to gastric volume
- ”Starry Night”
  - Multiple air bubbles on hypoechoic background
  - Seen shortly after ingestion of clear fluids or effervescent drinks
- NOTE: volume assessment can differentiate a low (normal) quantity of baseline gastric secretions from a higher (non-fasted) volume


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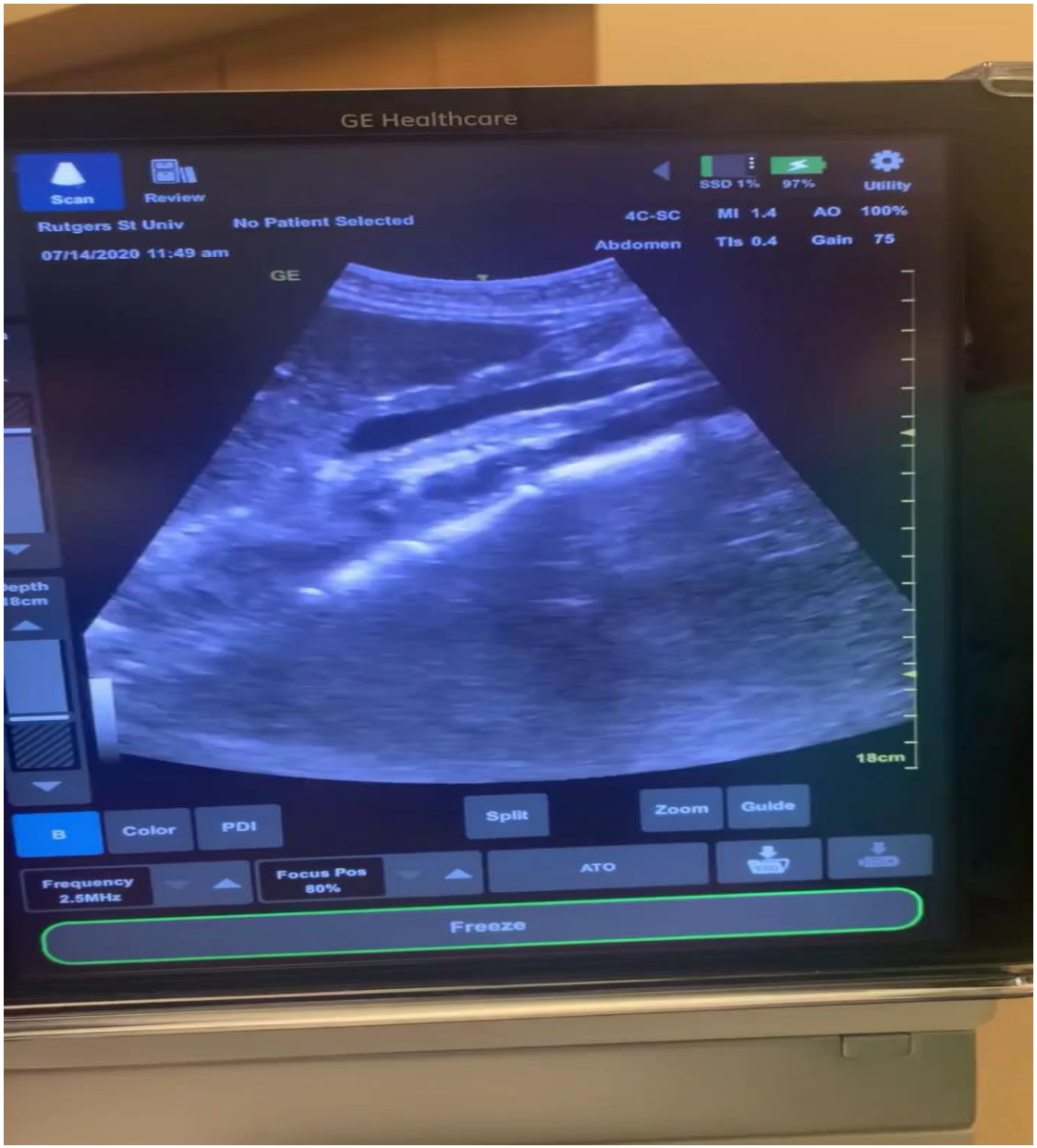
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Qualitative Assessment

- Assessed by visualization on ultrasound
- 3-Point Grading System
  - **Grade 0**: empty stomach → LOW ASPIRATION RISK
    - Negligible fluid
    - Empty in both supine and RLD position
  - **Grade 1**
    - Small, negligible fluid volume above baseline
    - Gastric fluid only seen in RLD
  - **Grade 2**: Volume >1.5mL/kg or Particulate matter → HIGH ASPIRATION RISK
    - Particulate matter seen in both supine and RLD position

Quantitative Assessment: CSA of Antrum

- Only for assessment of **clear fluid** NOT **solid content**
  - Is amount of liquid in stomach Grade I or II?
  - Any particulate matter detection is an automatic Grade II
- Antral CSA has a linear correlation with the gastric volume

To measure:

1. Identify antrum at the level of aorta in RLD
2. Freeze screen with antrum at rest (between peristaltic contractions
3. Outline antrum with area mode (include full thickness of the gastric wall from serosa to serosa)
4. Press calculate on ultrasound
5. Apply to predictive model

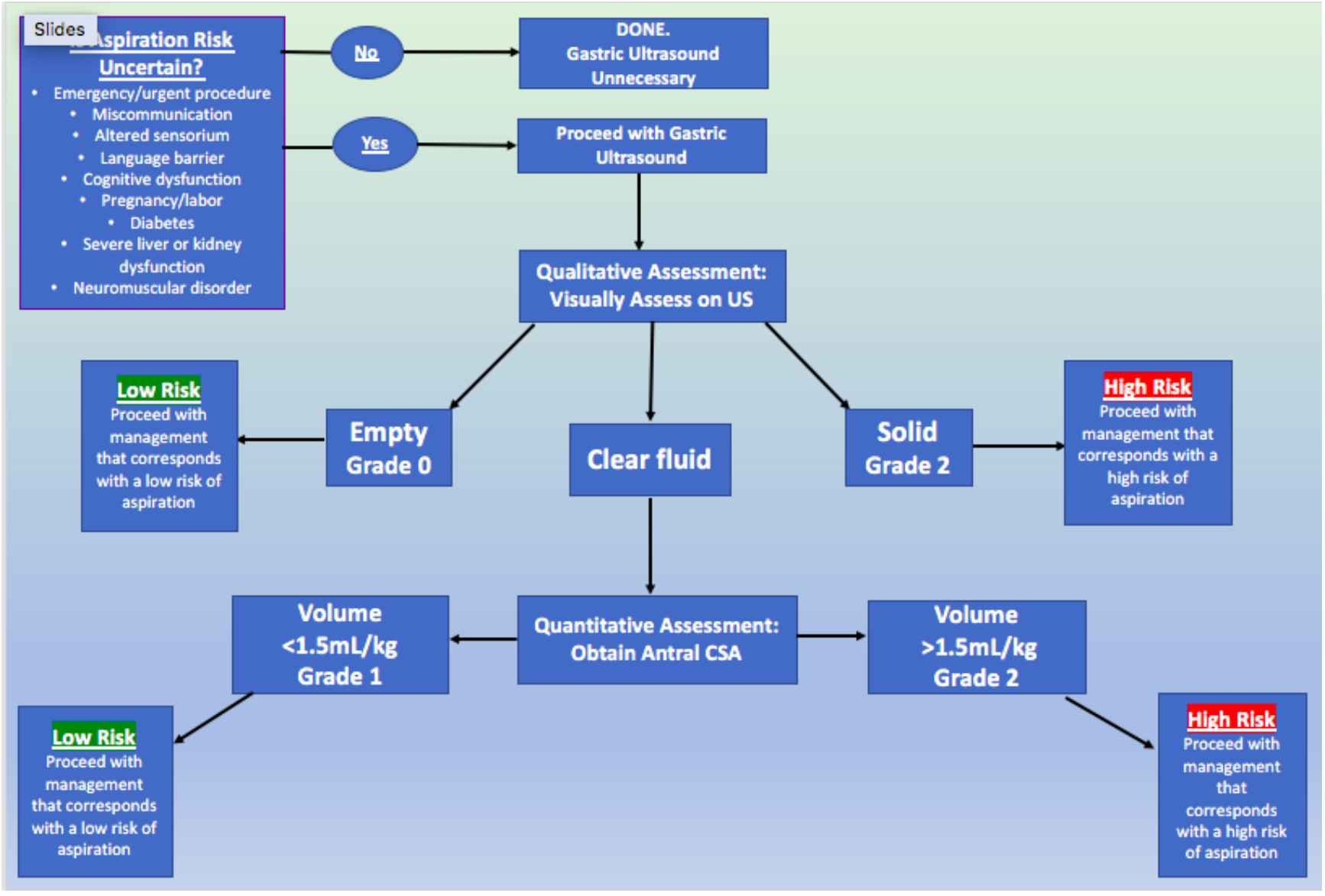
Measuring the Antrum CSA

Formula for Quantitative Assessment

Gastric Volume (mL) = 27 + (14.6 x RLD CSA) - 1.28 x age (years)

Right lat CSA (cm^2)	Age (years)						
	20	30	40	50	60	70	80
3	45	32	20	7	0	0	0
5	74	62	49	36	23	10	0
7	103	91	78	65	52	40	27
9	133	120	107	94	82	69	56
11	162	149	136	123	111	98	85
13	191	178	165	153	140	127	114
15	220	207	194	182	169	156	143
17	249	236	224	211	198	185	173
19	278	266	253	240	227	214	202
21	307	295	282	269	256	244	231
23	337	324	311	298	285	273	260
25	366	353	340	327	315	302	289
27	395	382	369	357	344	331	318
29	424	411	398	386	373	360	347

Clinical Decision Making



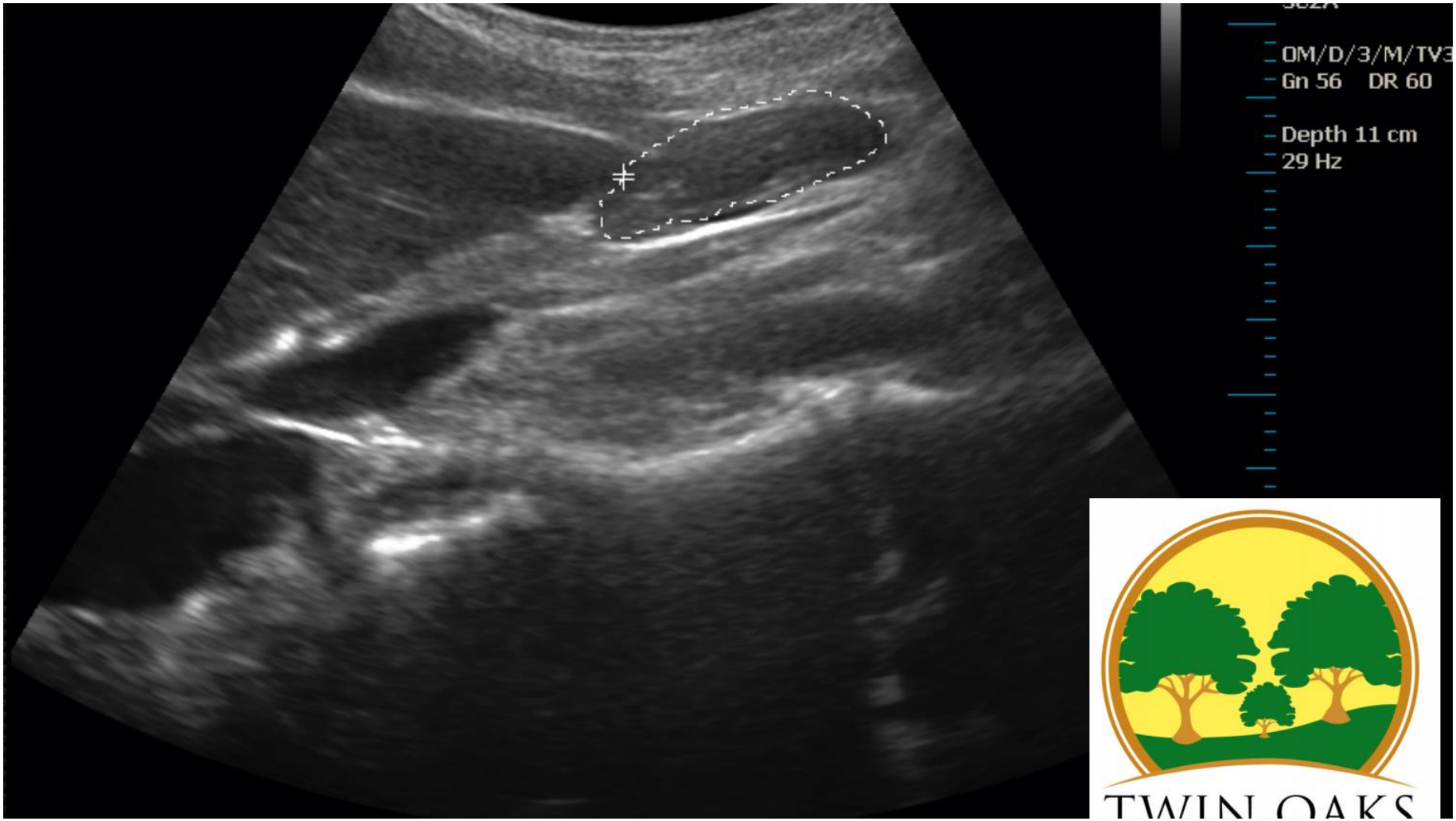
Scanning Tips

- Always identify your landmarks: liver and aorta/IVC
- Focus on area below below liver tip and in front of vessels
- If you can't identify in supine, change to RLD
- Ask the patient to take a slow deep breath
  - Moves transverse colon down
- Increased fluid = increased viewing of deeper structures
- Fan and rotate your probe
- Remember: in 2-3% of patients the antrum may not be identifiable
- Remember these helpful image terms:
  - Bulls Eye = empty stomach
  - Frosted Glass = solid food in antrum
  - Starry Night = liquid content in antrum

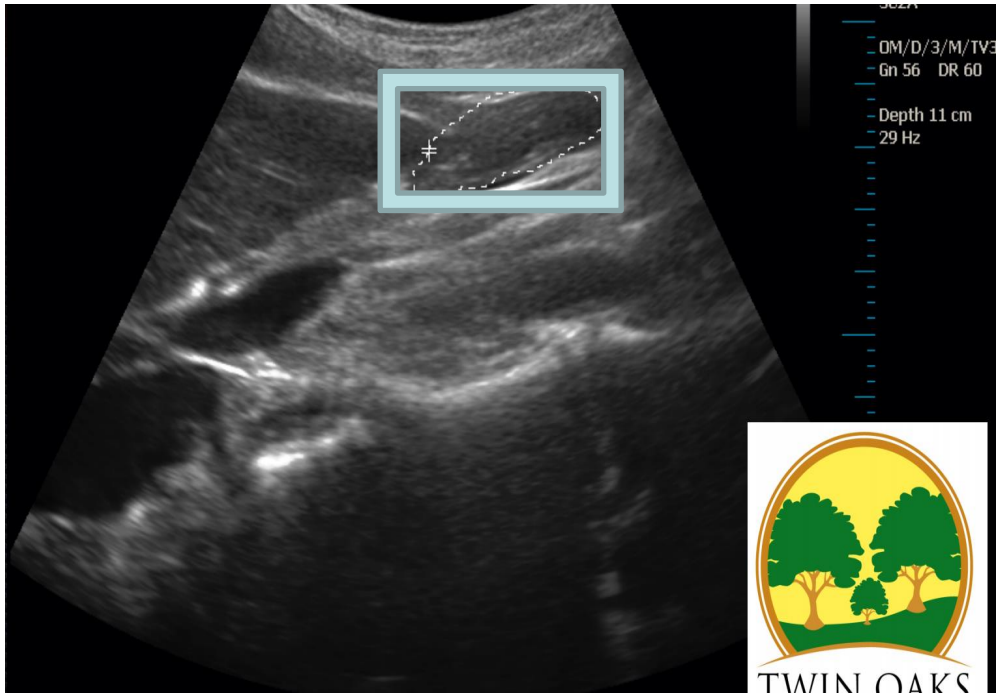
FAQs

- Do I have to scan in supine, or can I just scan in RLD?
  - Scanning in supine is helping because 1) if solid or thick fluid is observed then the stomach is a Grade II and the exam is complete, and 2) scanning in both positions allows for a qualitative evaluative of volume
- Is 1.5mL/kg in reference to IBW or TBW?
  - Total Body Weight
- Why does age matter when predicting the volume of fluid in the antrum?
  - Older patients tend to have a higher CSA in their antrum, which is hypothesized to be do to a more compliant gastric wall.
- If I can not locate the antrum, can I assume the stomach is empty?
  - The exam should be considered inconclusive if one is unable to find the stomach. In 2-3% of patients the antrum may be be located. It could be posterior to the colon and therefore not able to be appreciated by the ultrasound.

Practice Scans

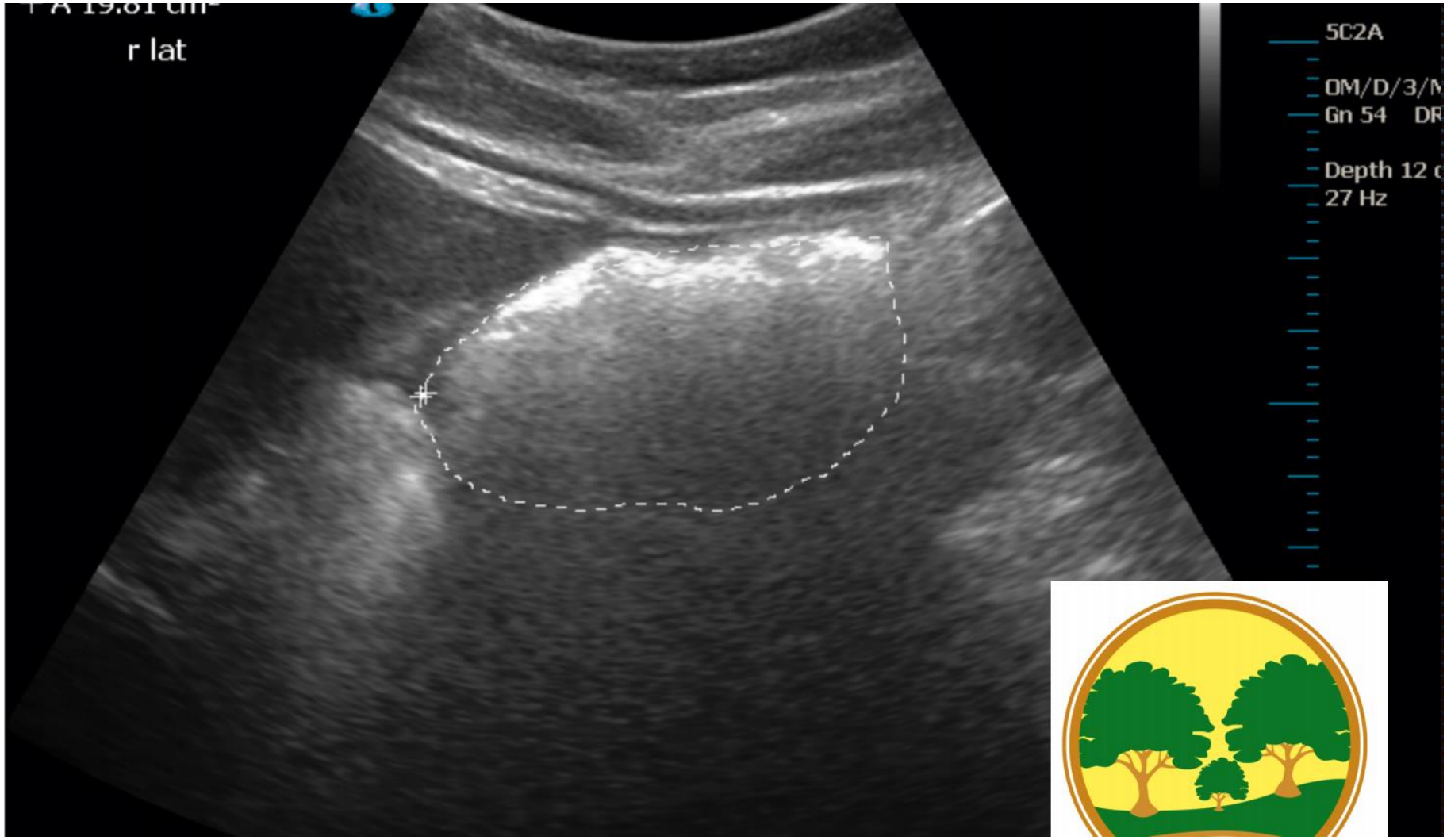

OM/D/3/M/TV3
Gn 56 DR 60
Depth 11 cm
29 Hz
TWIN OAKS

LIQUID

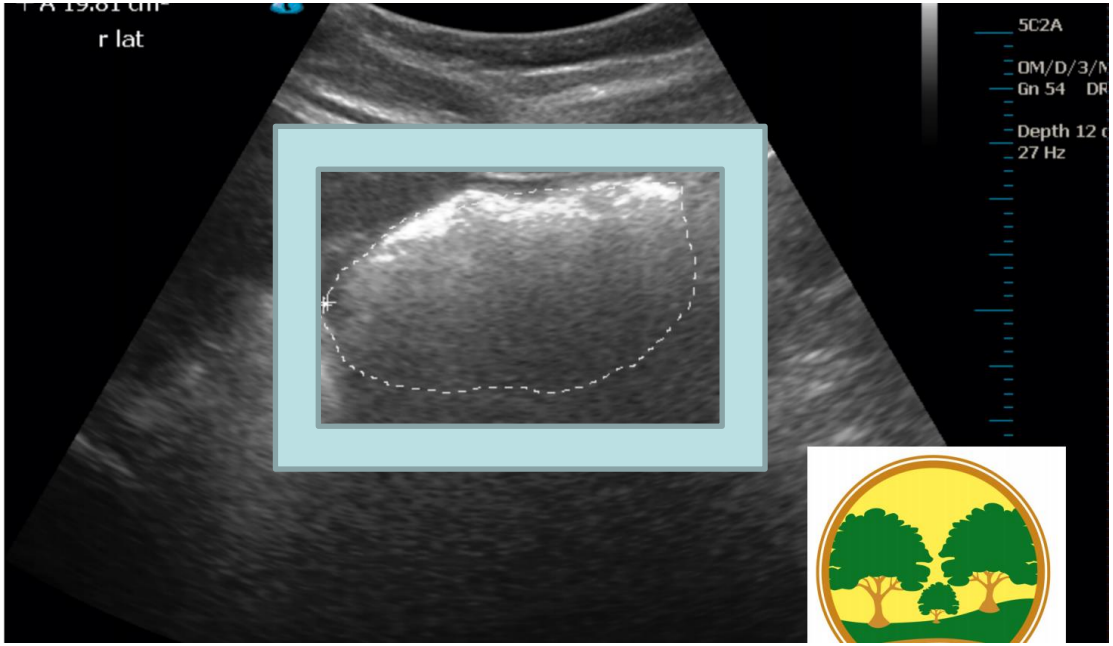


WHY?

- Distended, thin walls.
- Hypoechoic/ anechoic content
- Enhanced view of deeper vascular structures

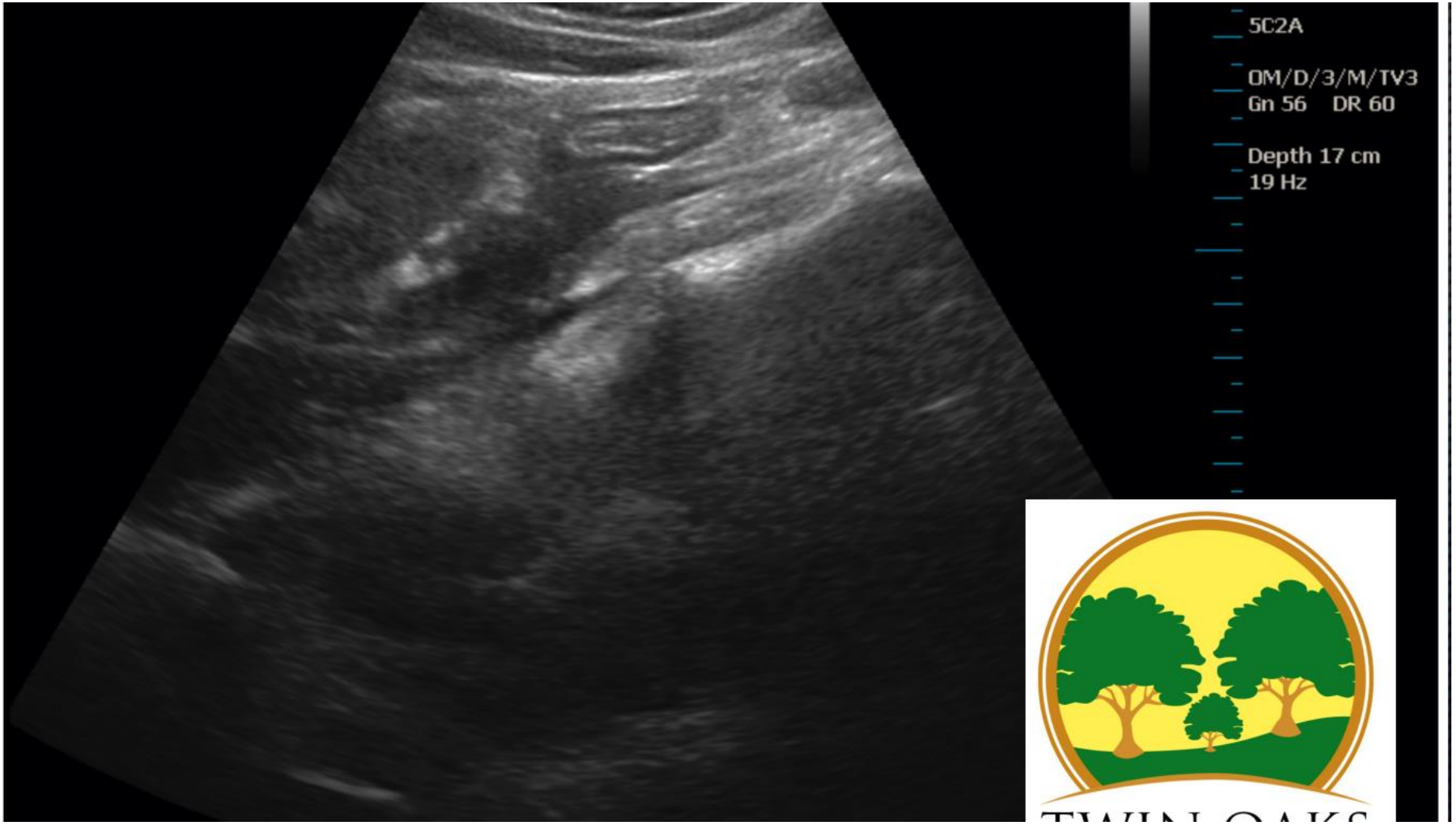

r lat
5C2A
Gn 54
Depth 12
27 Hz

EARLY SOLID

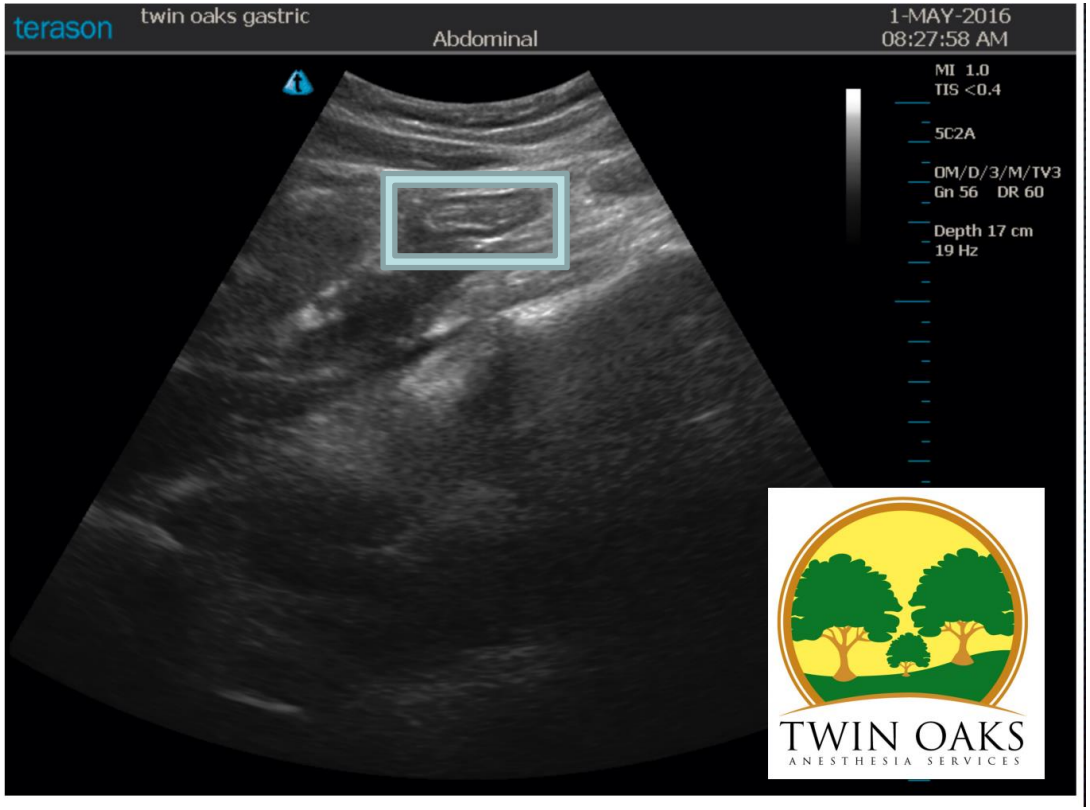


WHY?

- Distended, thin wall
- Consumption of food/air with eating → Mixed echogenicity aka "Frosted glass" appearance
- Blurring of posterior wall/ deeper structures

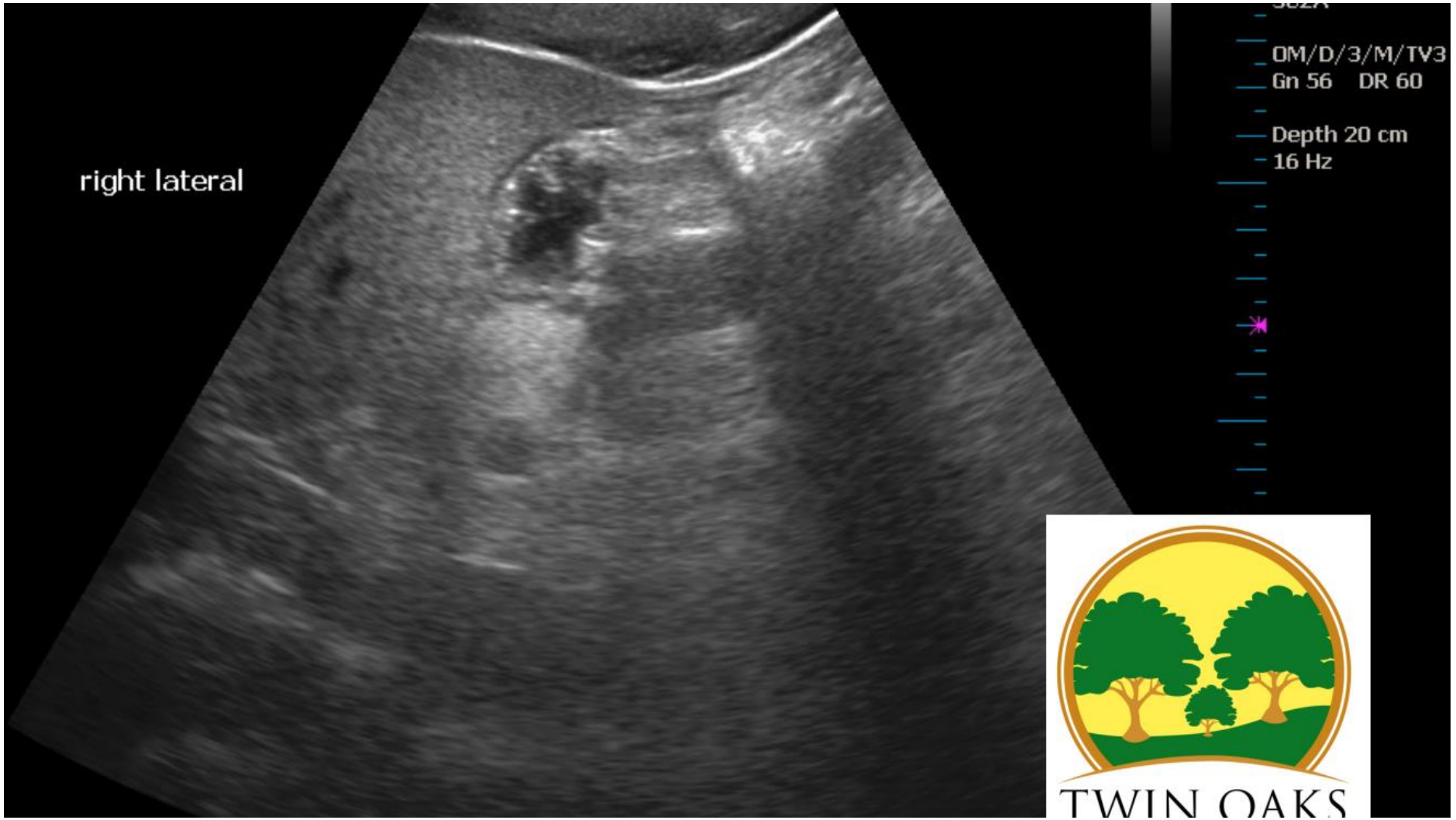

5C2A
OM/D/3/M/TV3
Gn 56 DR 60
Depth 17 cm
19 Hz

EMPTY

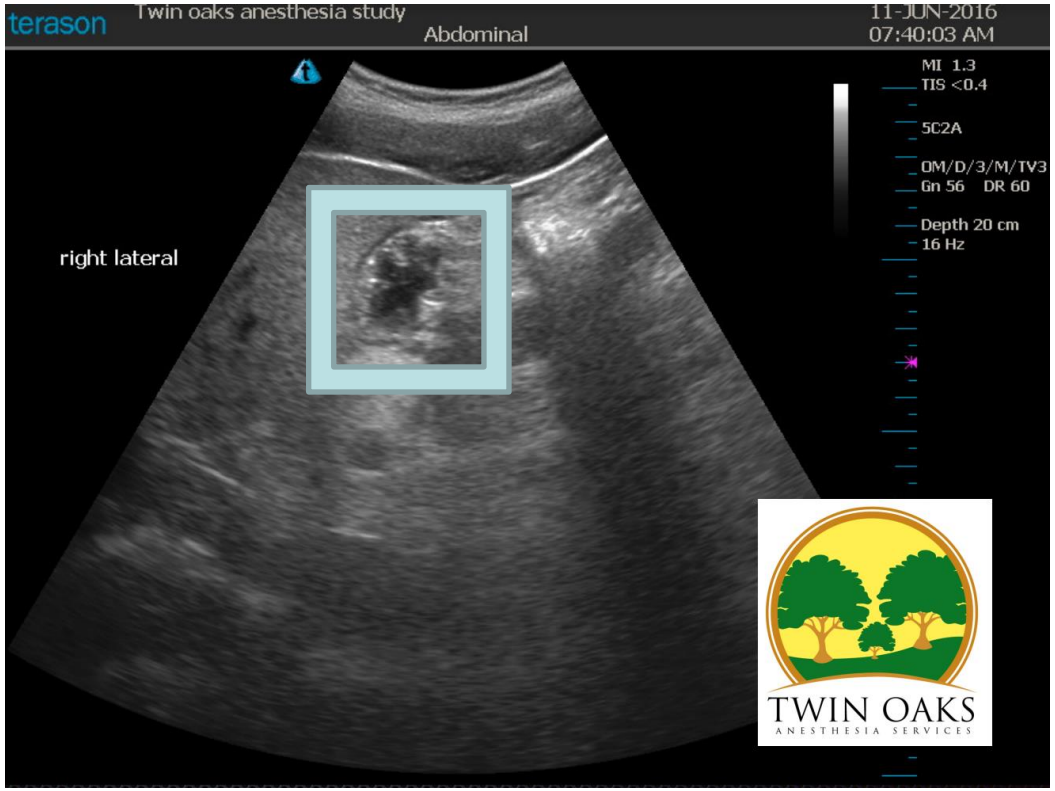


WHY?

- Small
- Flat/compressed
- Can see muscle layers
- Round/ovoid
- “Bulls eye”

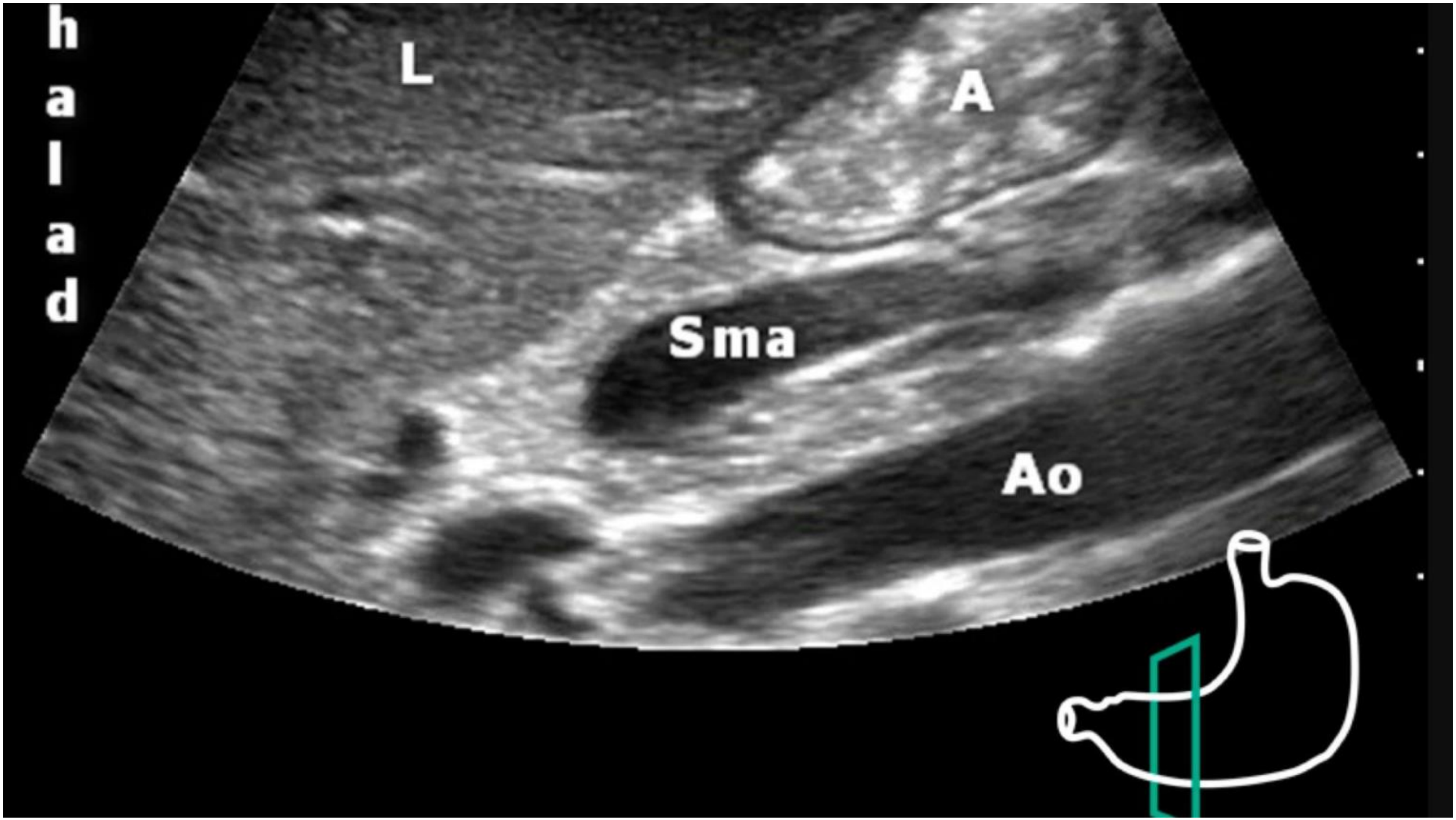

right lateral
OM/D/3/M/TV3
Gn 56 DR 60
Depth 20 cm
16 Hz
TWIN OAKS

EMPTY



WHY?

- Rugae with small amount of baseline secretions (anechoic center)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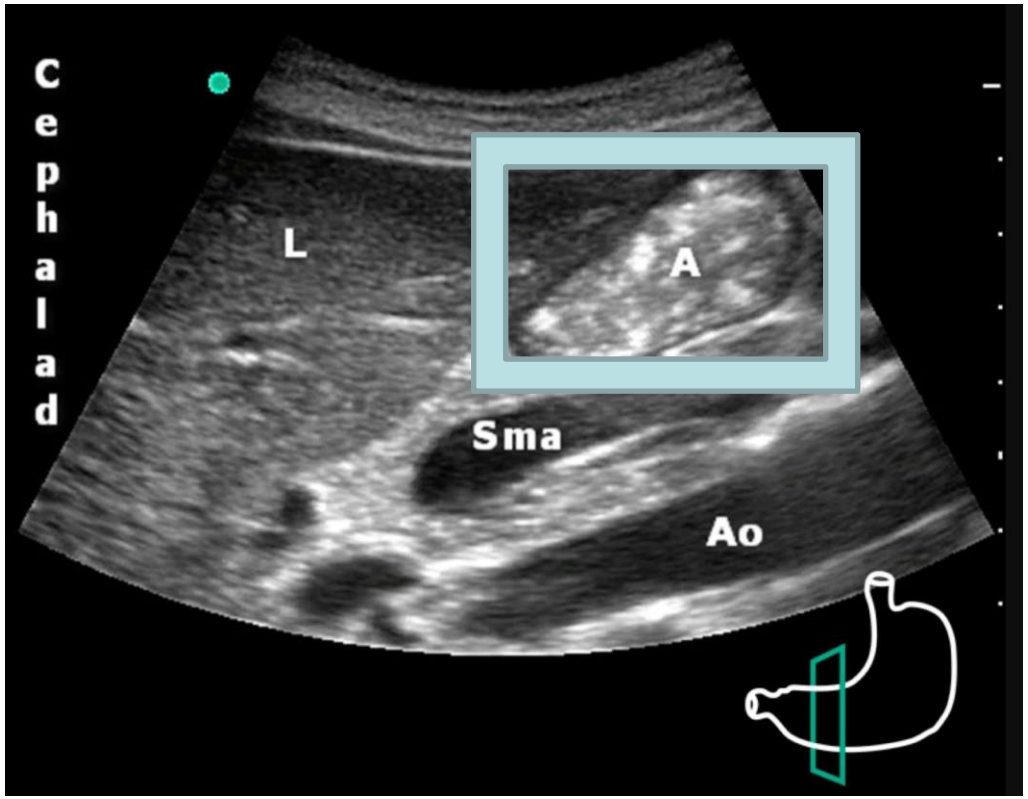
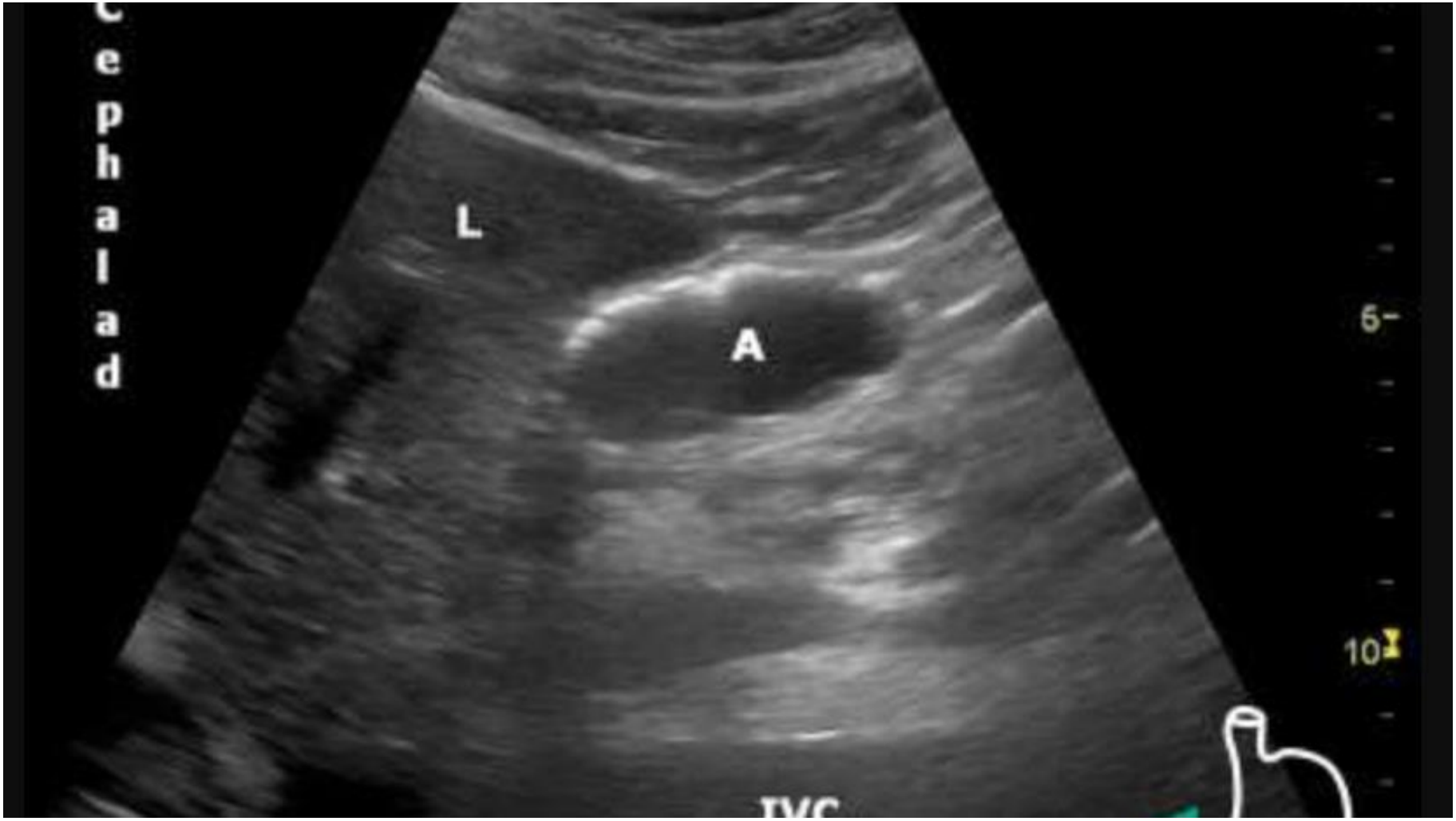


WHY?

- Distended, thin wall
- Round, heterogenous mass in center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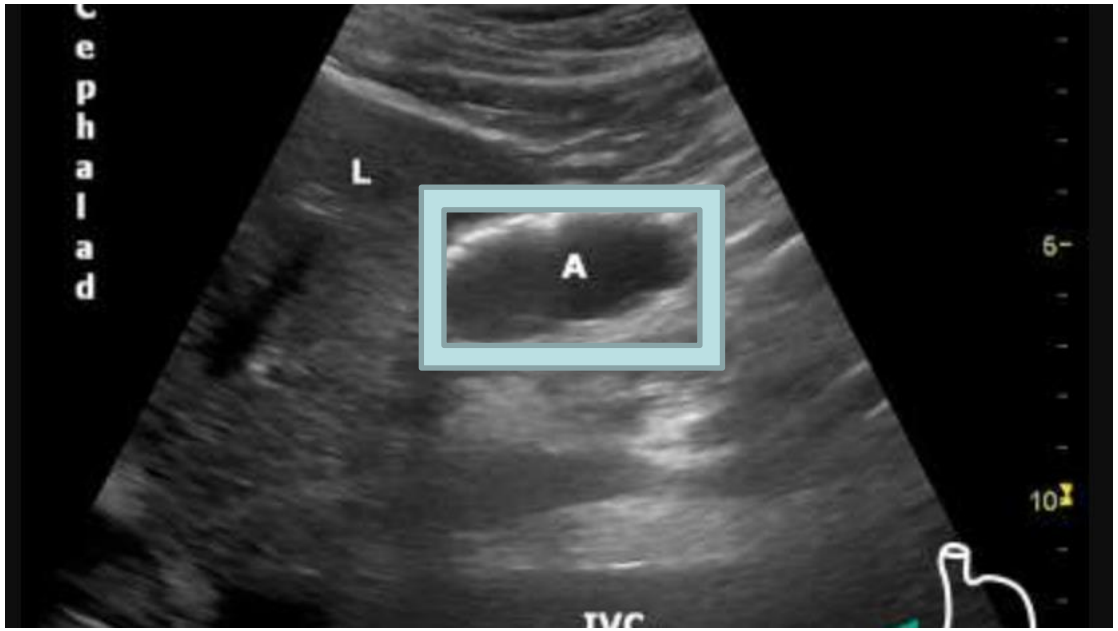
CLEAR LIQUID



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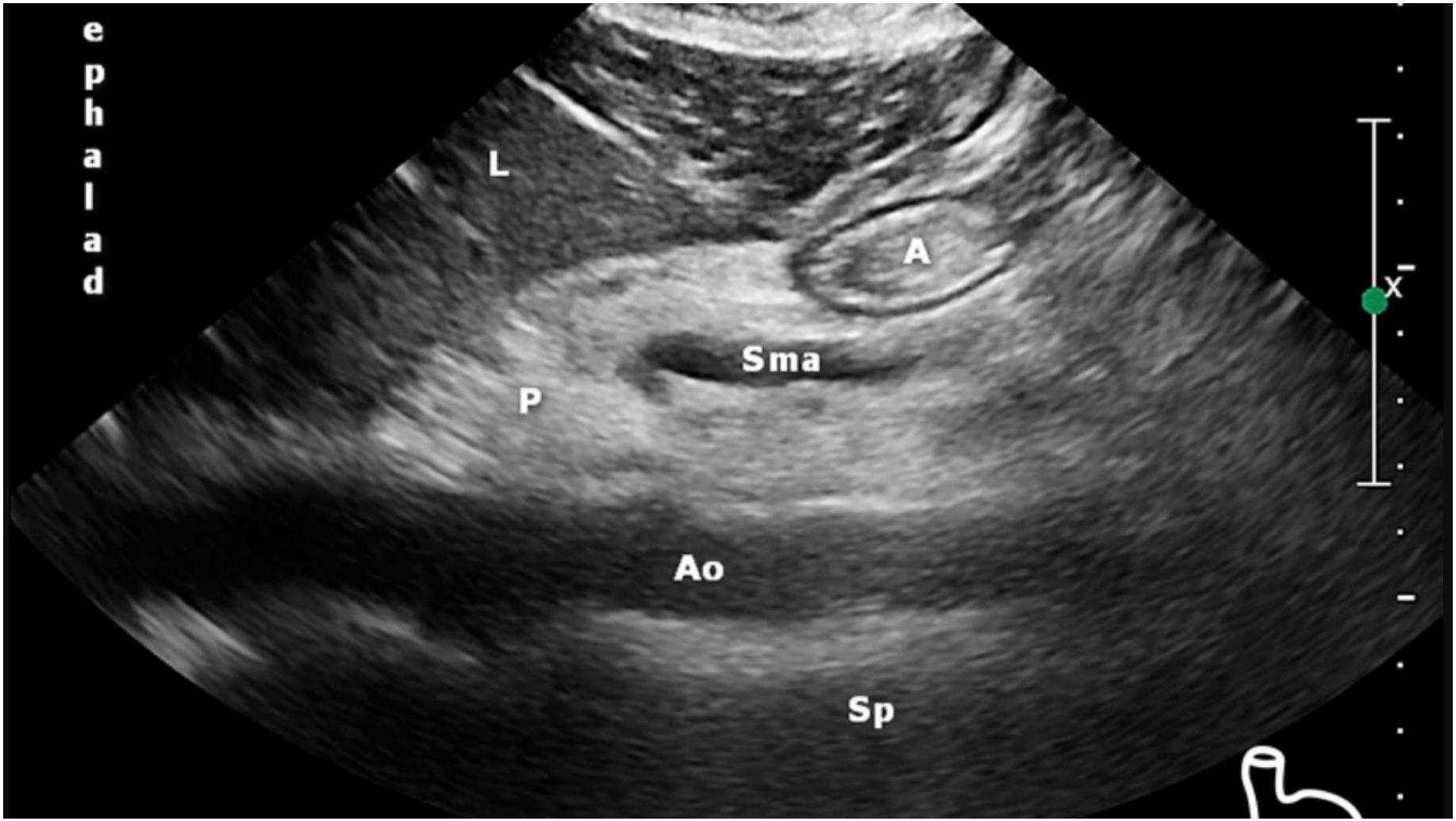
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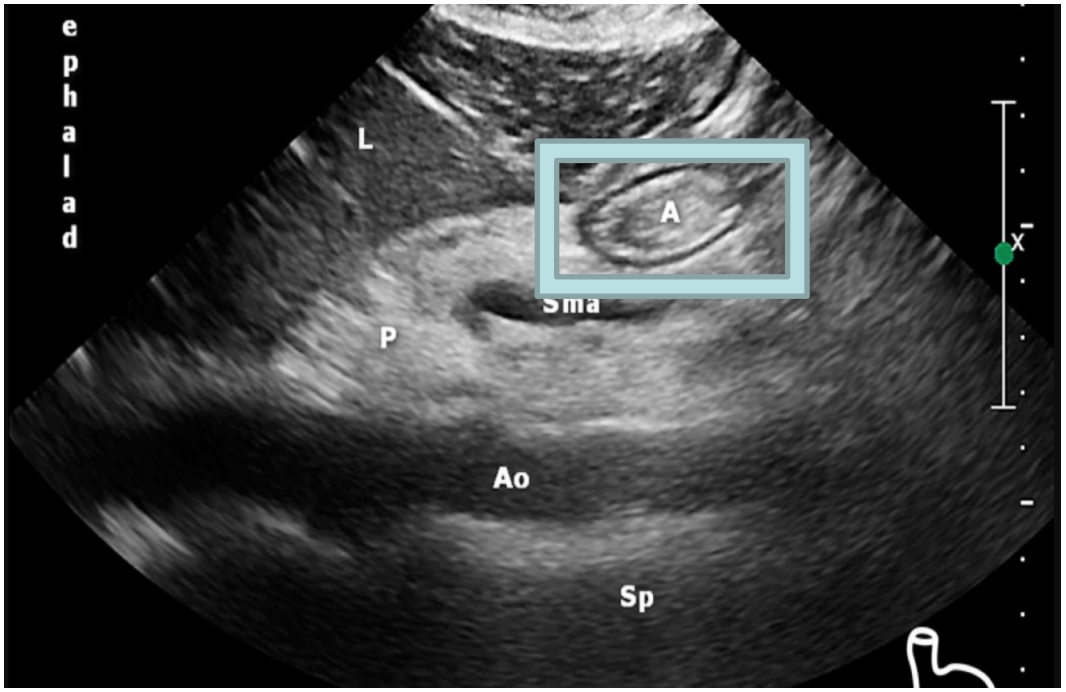
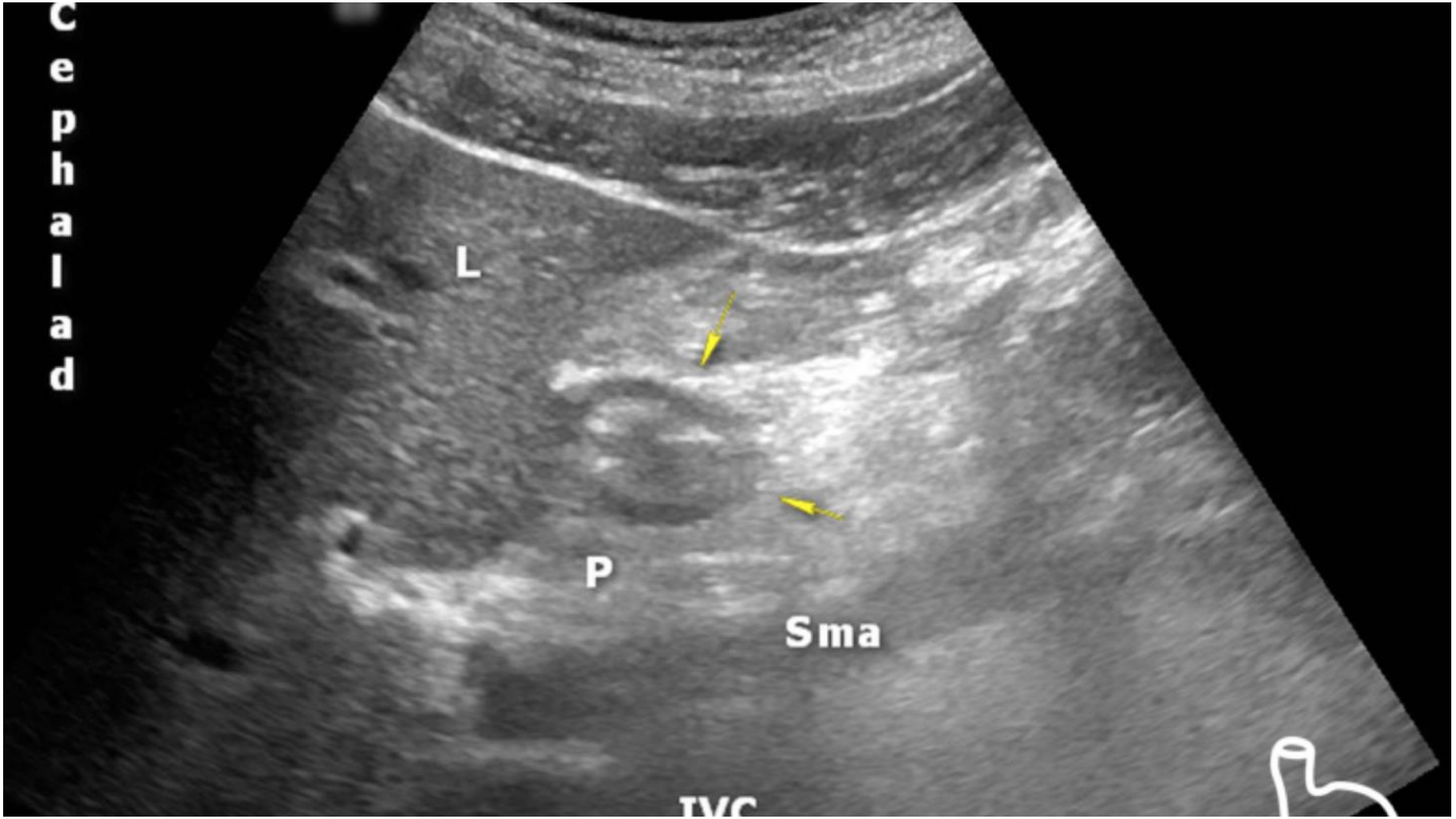


WHY?

- Small
- Constricted
- Can see muscle layers
- Flat/compressed
- Round/ovoid


Cephalad
L
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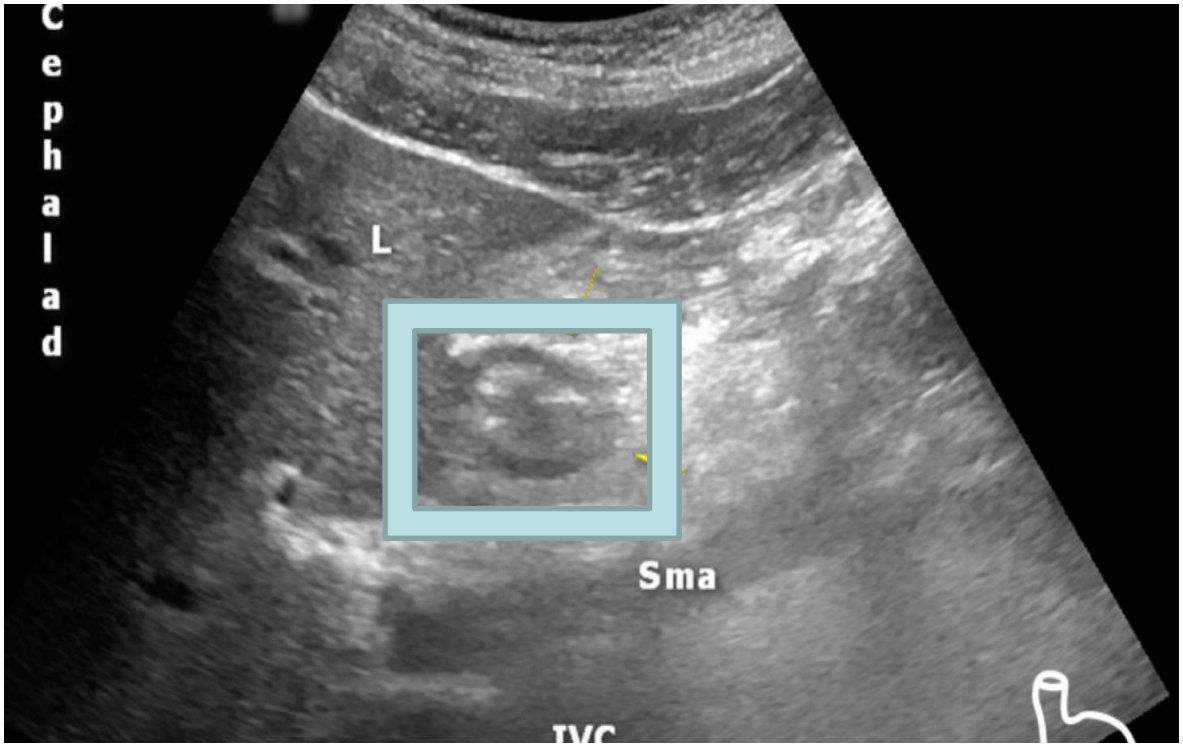
Sma
IVC

EMPTY



WHY?

- Small
- Constricted
- Can see muscle layers
- Flat/compressed
- Round/ovoid
- “Bulls eye”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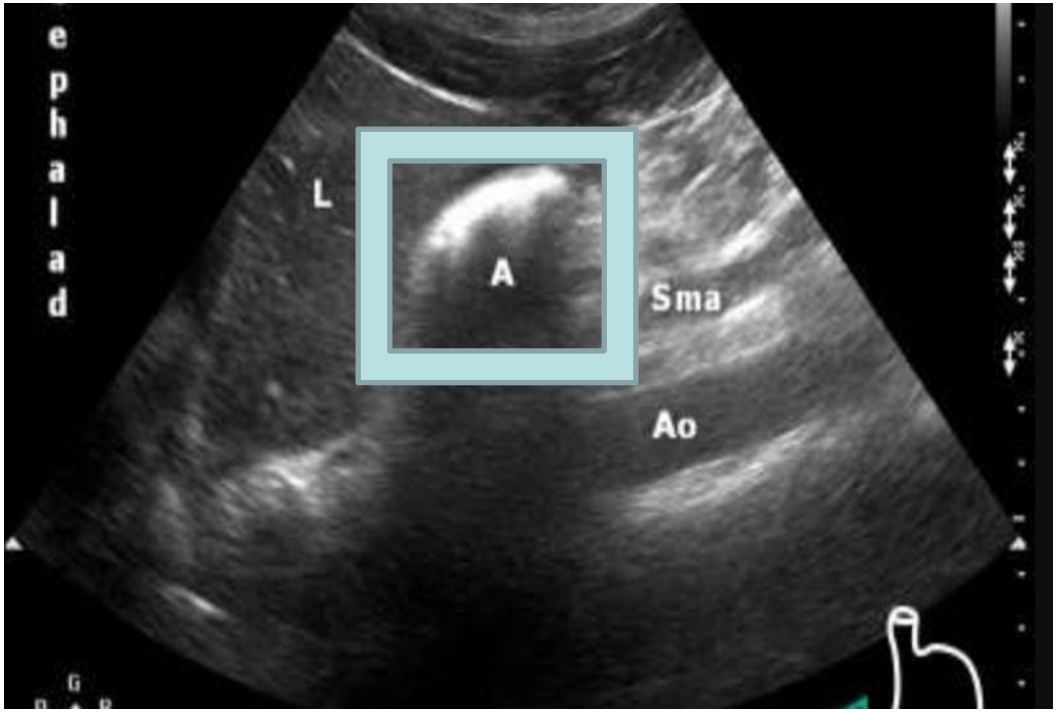
EARLY SOLID



WHY?

- Distended, thin wall
- Consumption of food/air with eating → Mixed echogenicity aka "Frosted glass" appearance
- Blurring of posterior wall/ deeper structures

Practice Dexterity of US Probe

Questions?

Please take a moment to fill out a
Post-Intervention Test
found at the link below

(Link posted in chat):
https://rutgers.ca1.qualtrics.com/jfe/form/SV_0SRJIWmVzcz9A33

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