Emergency Biliary Ultrasound

Gavin Budhram, MD
Division of Emergency Ultrasound
Department of Emergency Medicine
Baystate Medical Center

Objectives

- review biliary anatomy
- technical considerations
- common presentations of cholelithiasis
- gallbladder inflammation
- ultrasound in ED workup
- common artifacts

Clinical Utility

- Faster discharge of patients with uncomplicated biliary colic
- Faster diagnosis in critically ill patients with biliary pathology
- Consultative imaging still needed if technically inadequate images
- Acute cholecystitis necessitates further imaging

Clinical Utility

- 109 patients with RUQ pain had EP and formal US studies (blinded)
- Gallstones detected with 96% sensitivity. (49/51)
- 51/58 without gallstones correctly diagnosed
- Sonographic murphys more sensitive by EP's (75%) than by techs (45%)
- 83% of exams completed in less than 10 minutes

[1] Kendall JL, Shimp R. Performance and interpretation of focused right upper quadrant ultrasound by emergency physicians. *Jour Emerg Med* 2001: 21 7-13.

Clinical Utility

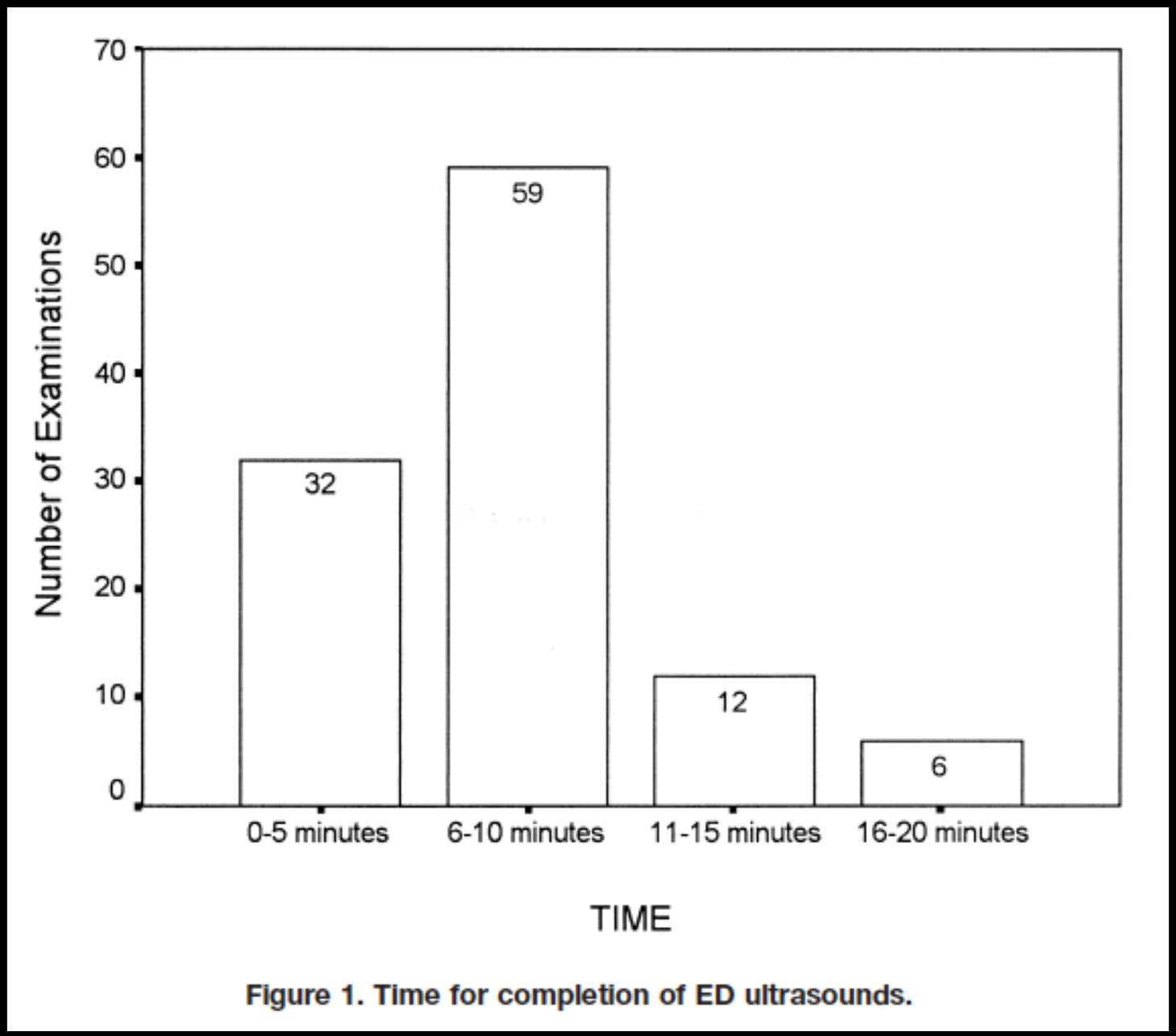


Figure 1. Time for completion of ED ultrasounds.

Clinical Utility

- Length of stay in 1242 patients receiving gallbladder US
  - 753 by EP's, 489 by Radiology
    - After hours, LOS decreased by 52 mins
    - Other times, LOS decreased by 22 mins
    - Discharged after hours LOS decreased by 1hr and 13 mins

[2] Blaivas M, Harwood, Lambert M. Decreasing length of stay with emergency ultrasound examination of the gallbladder. *Acad Emerg Med* 1999: 6(10) 1020-1023

Diagnostic Applications

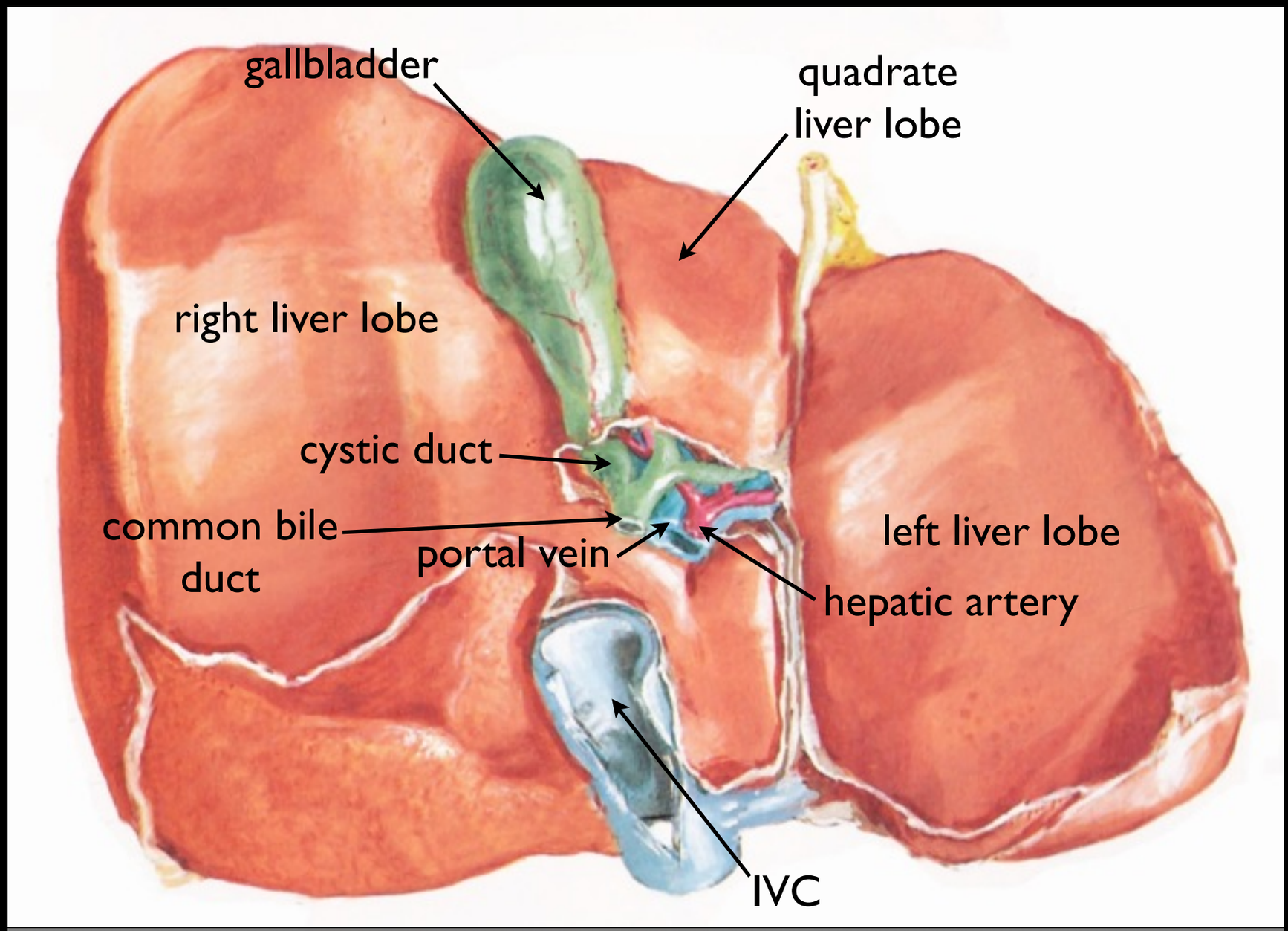
- Ultrasound can be used to facilitate the diagnosis of:
  - cholelithiasis
  - acute and chronic cholecystitis
  - jaundice
  - gallbladder sludge

Technical Considerations

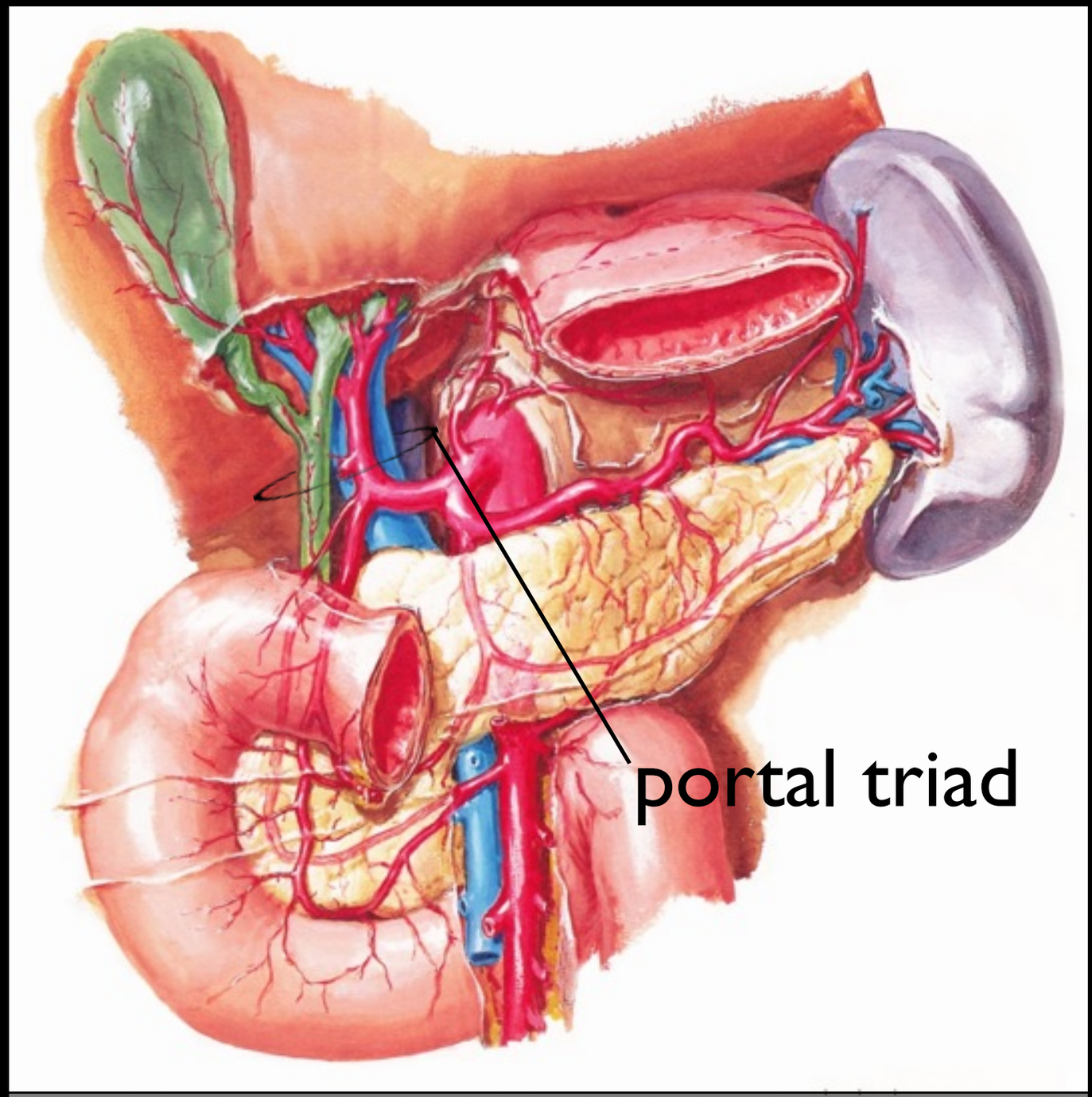
RUQ anatomy

- Complex organization of components
  - solid organs
  - hollow organs
  - portal vasculature
  - systemic vasculature
  - biliary tract
  - retroperitoneal viscera
  - intraperitoneal viscera

RUQ anatomy


gallbladder
quadrate
liver lobe
right liver lobe
cystic duct
common bile
duct
portal vein
left liver lobe
hepatic artery
IVC

RUQ anatomy



RUQ anatomy

- Gallbladder
  - usually easily visualized by ultrasound
  - fluid-filled structure
  - three layered wall
    - strongly reflective outer layer
    - minimally reflective inner layer
    - anechoic layer in between
  - wall thickness is less than 2mm in 97%

RUQ anatomy

- Common bile duct
  - runs parallel to the portal vein and superior to it
  - *internal diameter <4mm in 98% of normal individuals*
  - *>7mm is pathologic*

Patient Preparation

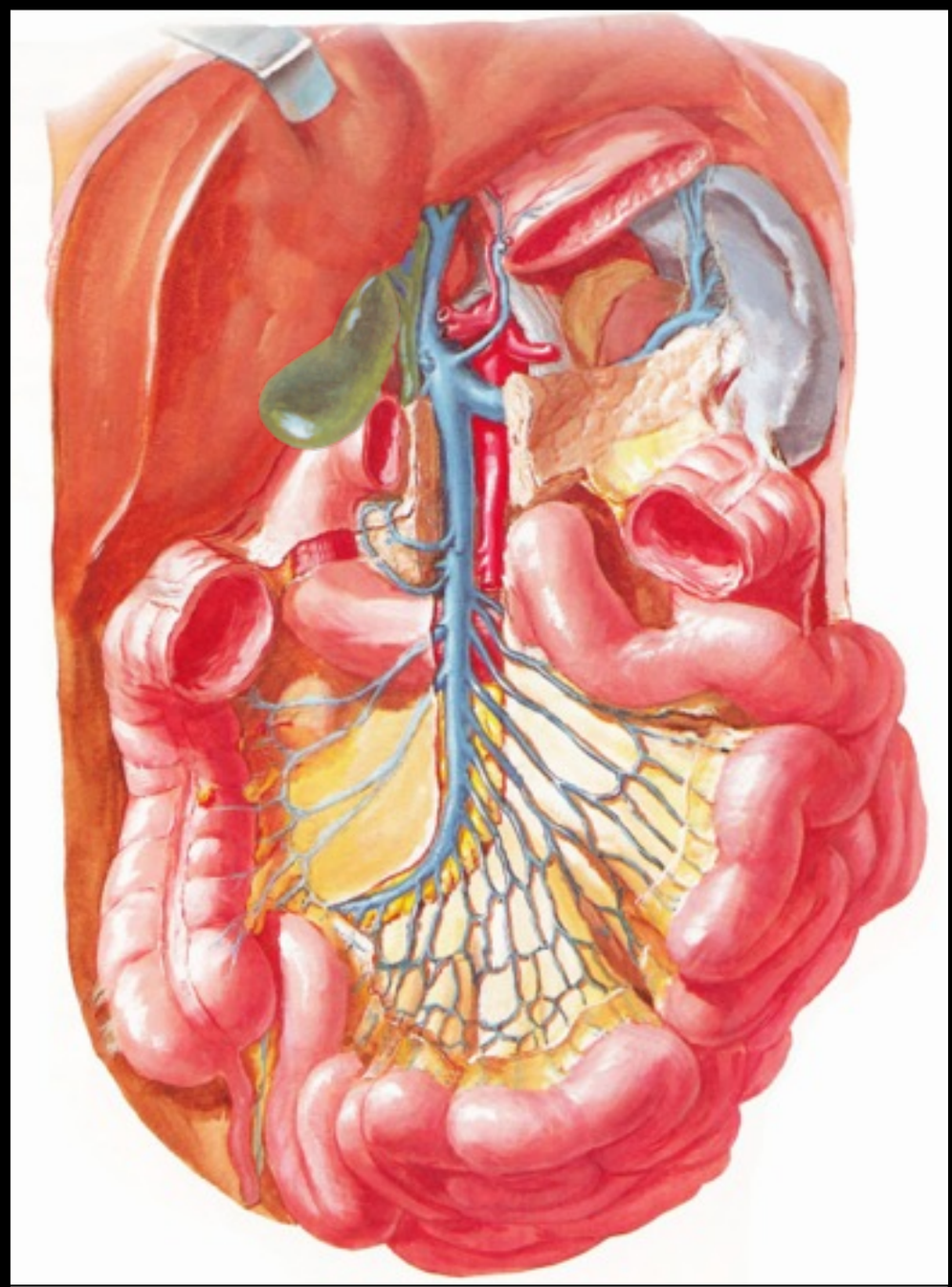
- food intake
  - gallbladder contraction
    - may make gallbladder difficult to find
- outpatient elective scanning
  - 6-8 hour fasting period required for this reason

Individual Anatomy

- factors that make study difficult
  - small liver (small sonographic window)
  - anterior gallbladder (small sonographic window)
  - excessive bowel gas
  - obesity

Patient Positioning

- patient positioning
  - left lateral decubitus is best
- positions gallbladder under liver



Normal Sonographic Findings

Sagittal Orientation

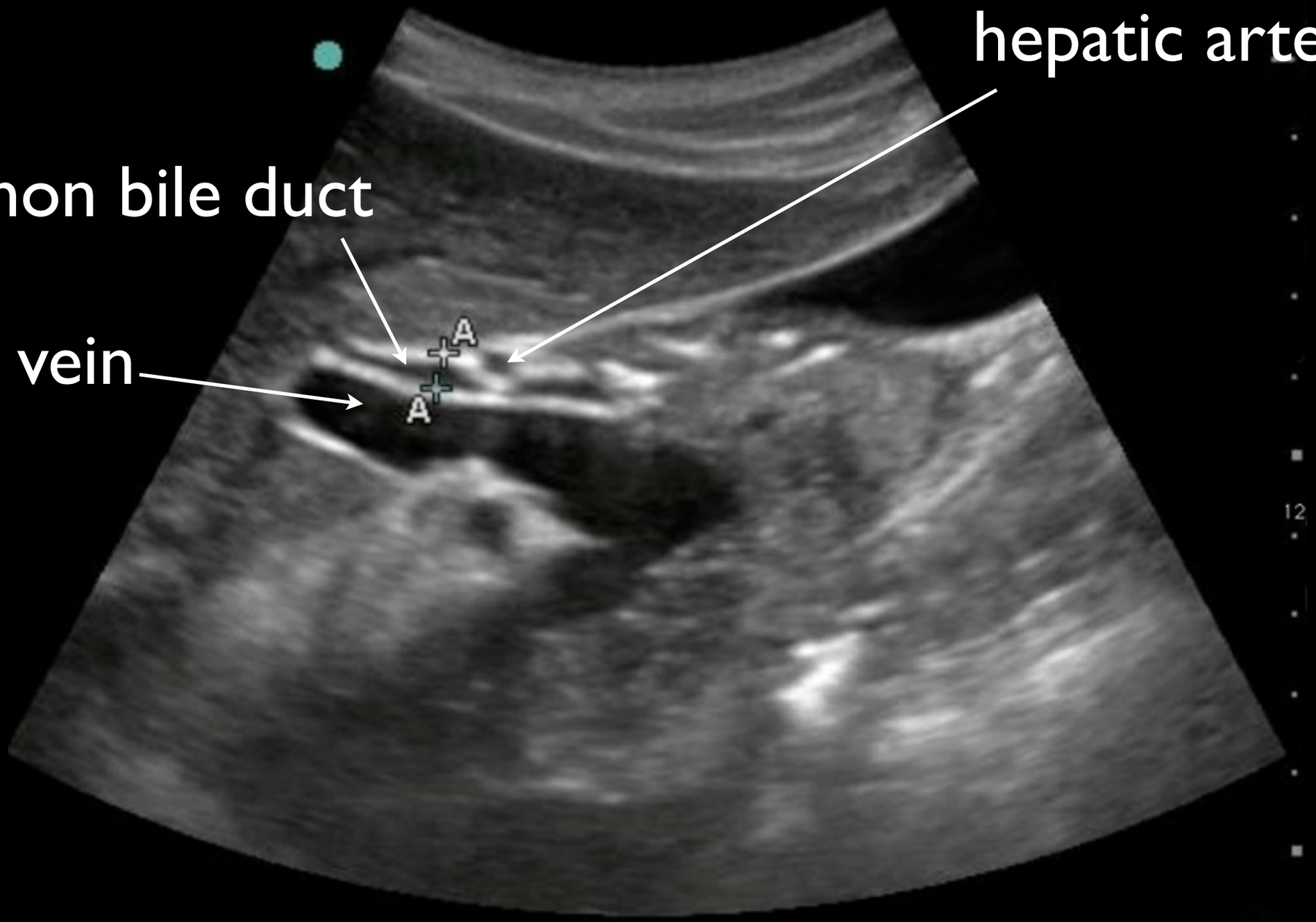
Normal Sonographic Findings

Sagittal Orientation

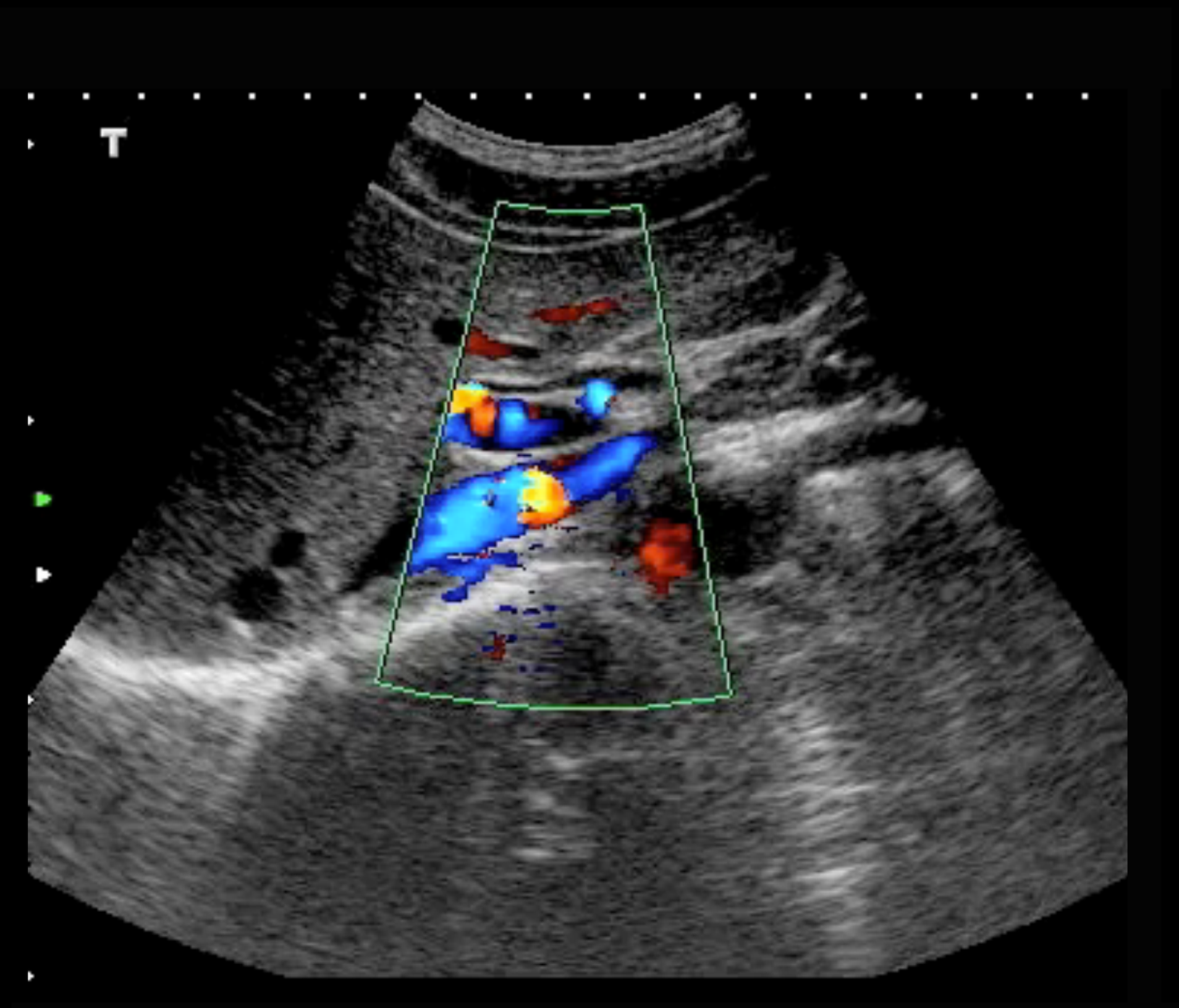
- Sweep back and forth for stones
- Evaluate for pericholecystic fluid
- Evaluate for wall thickening

Normal Sonographic Findings

Sagittal Orientation

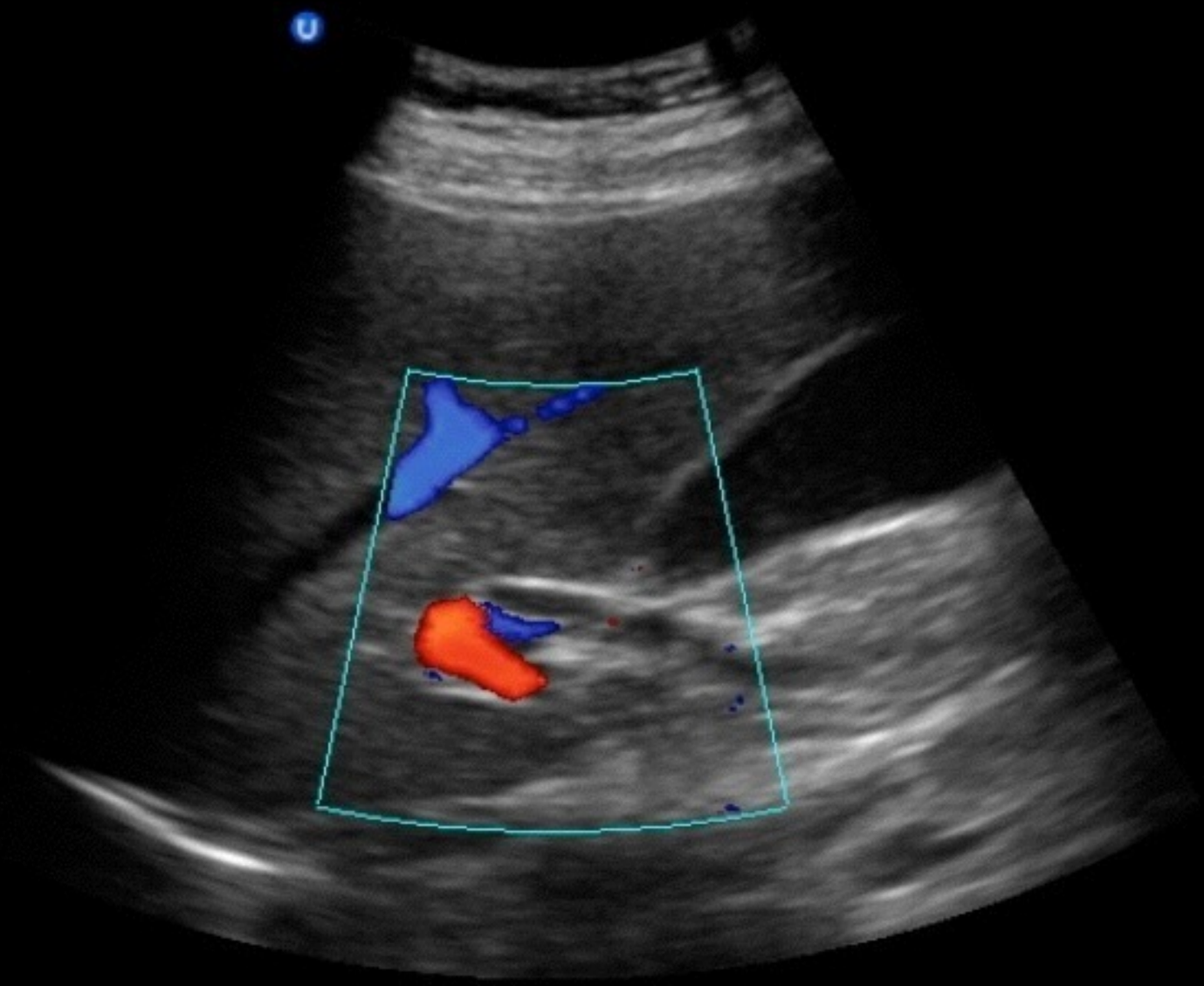


Sagittal Orientation



Normal Sonographic Findings

Sagittal Orientation

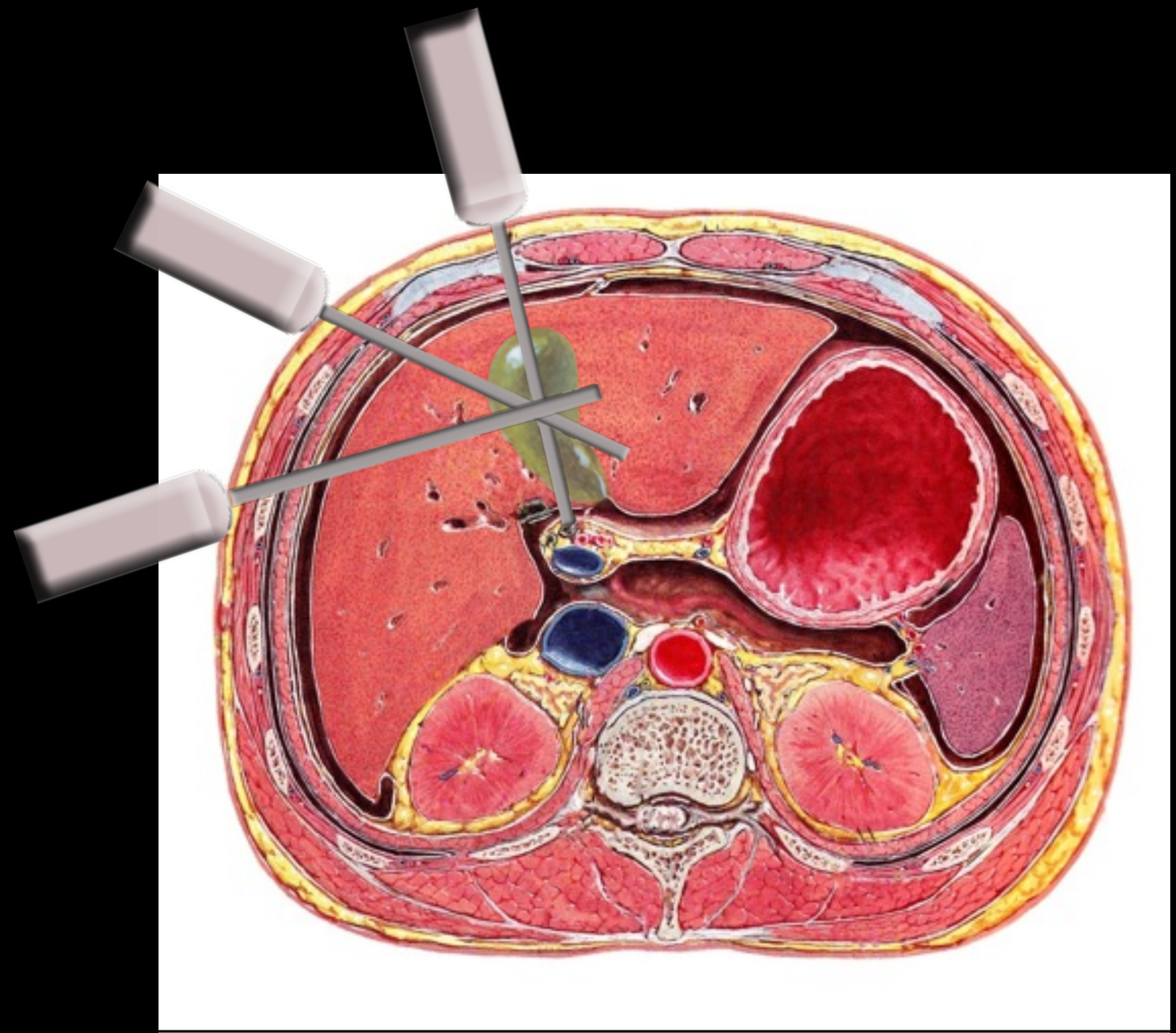


Sagittal Orientation

Coronal Orientation

- If sagittal view is difficult, may try coronal orientation
- May provide larger hepatic window

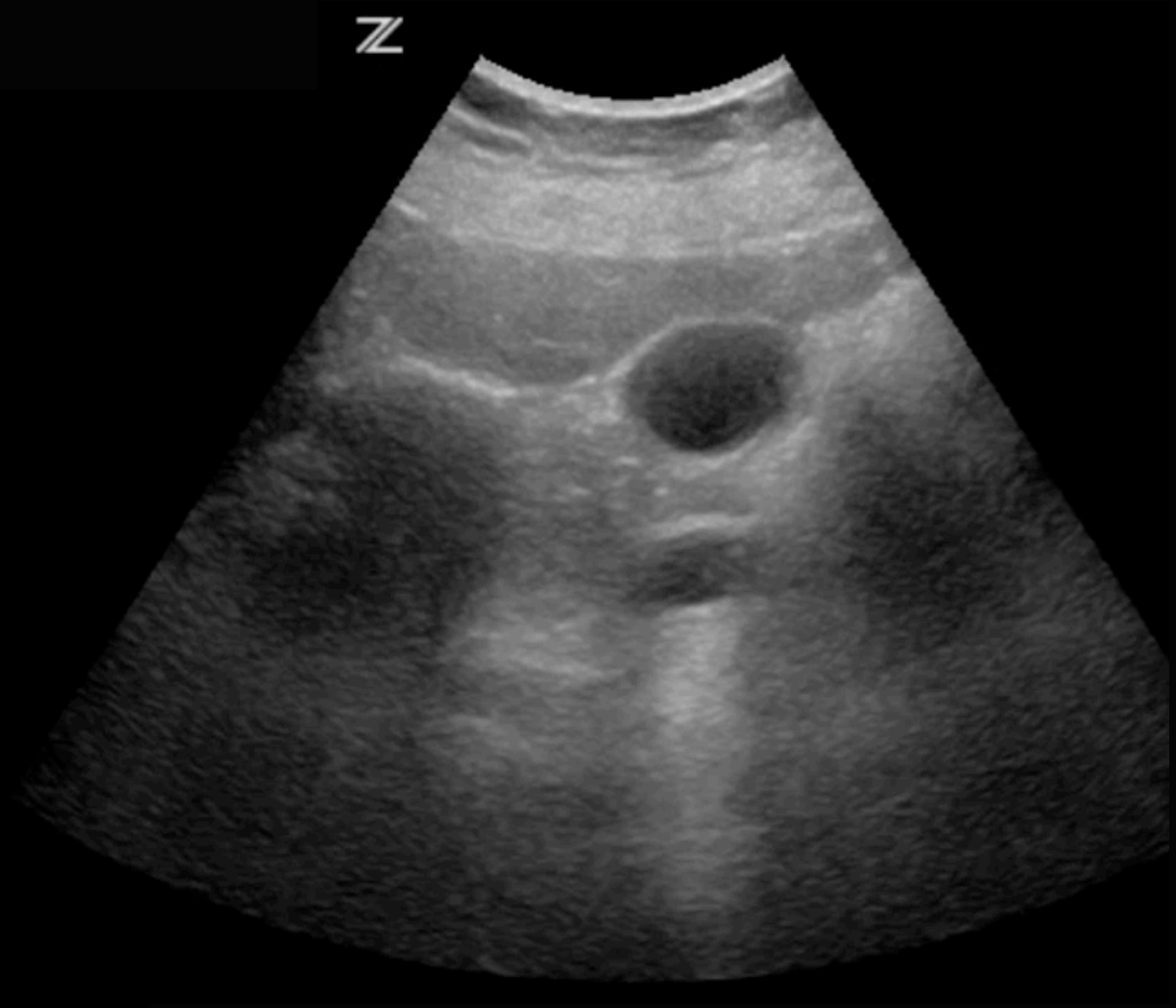
Coronal Orientation



Several approaches ⟶ same view!

Axial Orientation

Axial Orientation



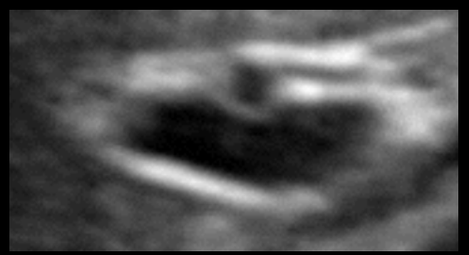
- Rotate probe counter-clockwise to obtain axial view
- Sweep up and down for stones
- Evaluate for pericholecystic fluid
- Evaluate for wall thickening

Axial Orientation

portal triad

Normal Sonographic Findings

Common Portal Triad Configurations



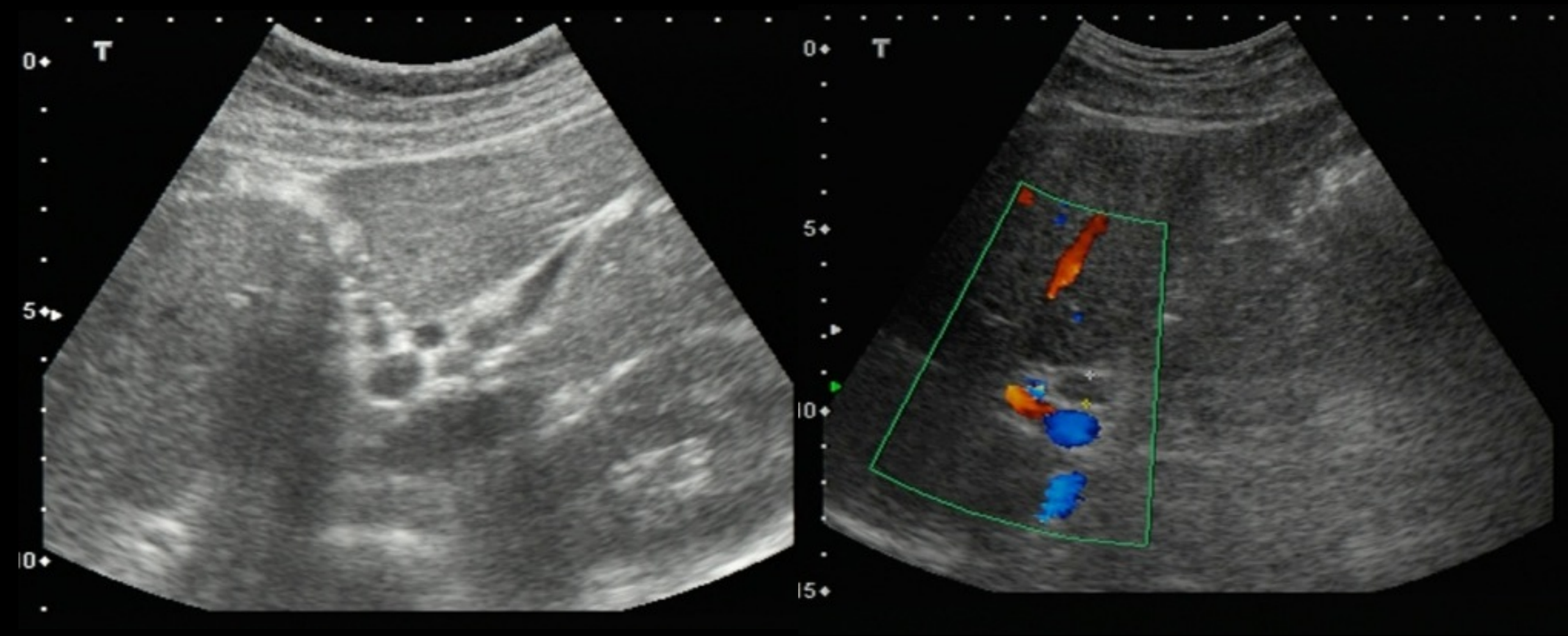
Hepatic artery between portal vein and common bile duct

Common bile duct parallel and superior to portal vein. Hepatic artery not seen.

All three components of portal triad in axial view - “mickey mouse sign”

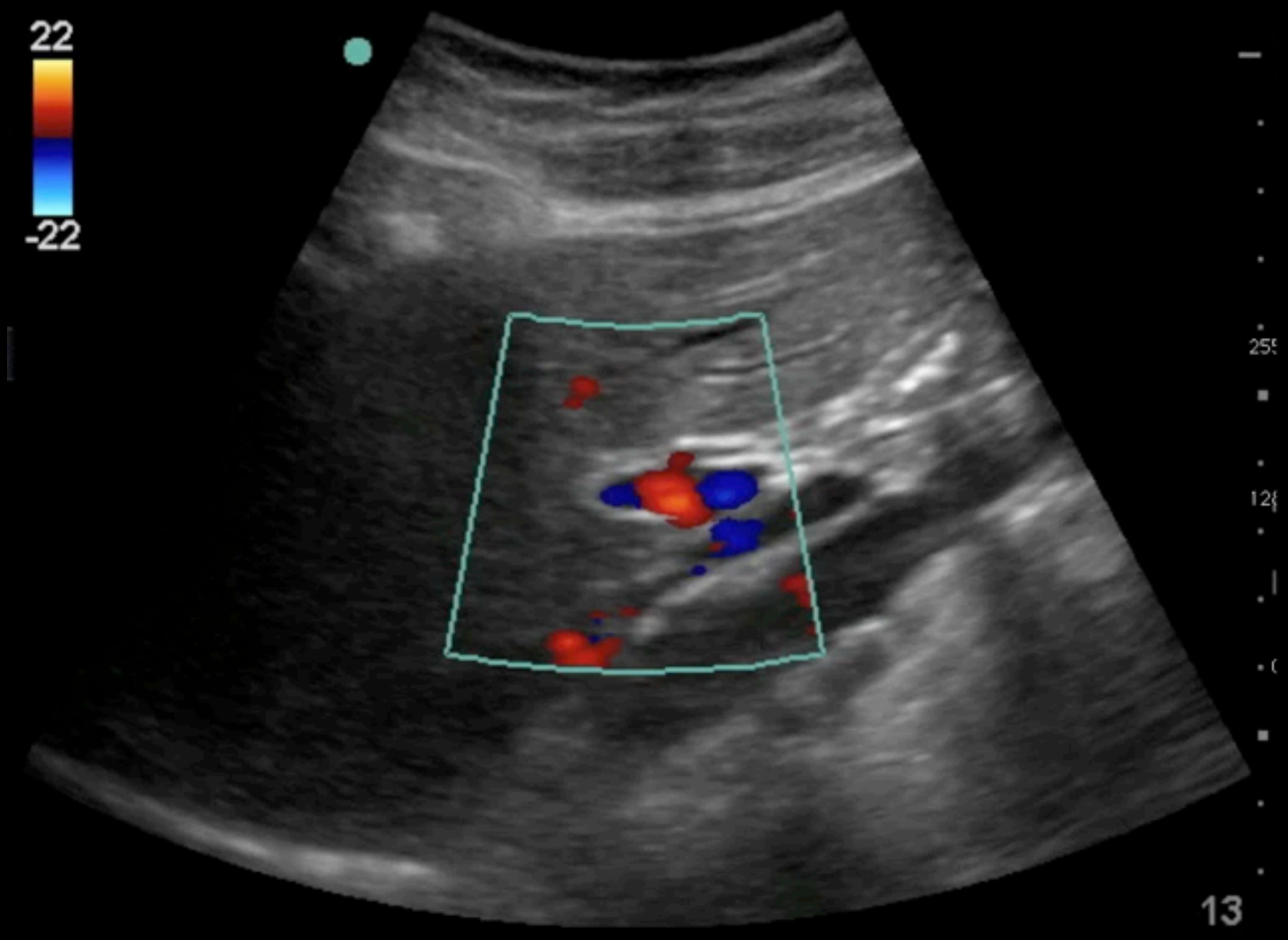
Normal Sonographic Findings

Axial Orientation



color may be used to identify the CBD

Sagittal Orientation



color may be used to identify the CBD

Sonographic Pathology

Cholelithiasis

- over 500,000 cholecystectomies each year in the U.S.
- Majority of gallstones are clinically silent
- 18-50% will develop pain or complications over a 10-15 year period

Cholelithiasis

- prevalence
- men: 6-10%
- women: 12-20%
- nearly equal with advancing age

Cholelithiasis

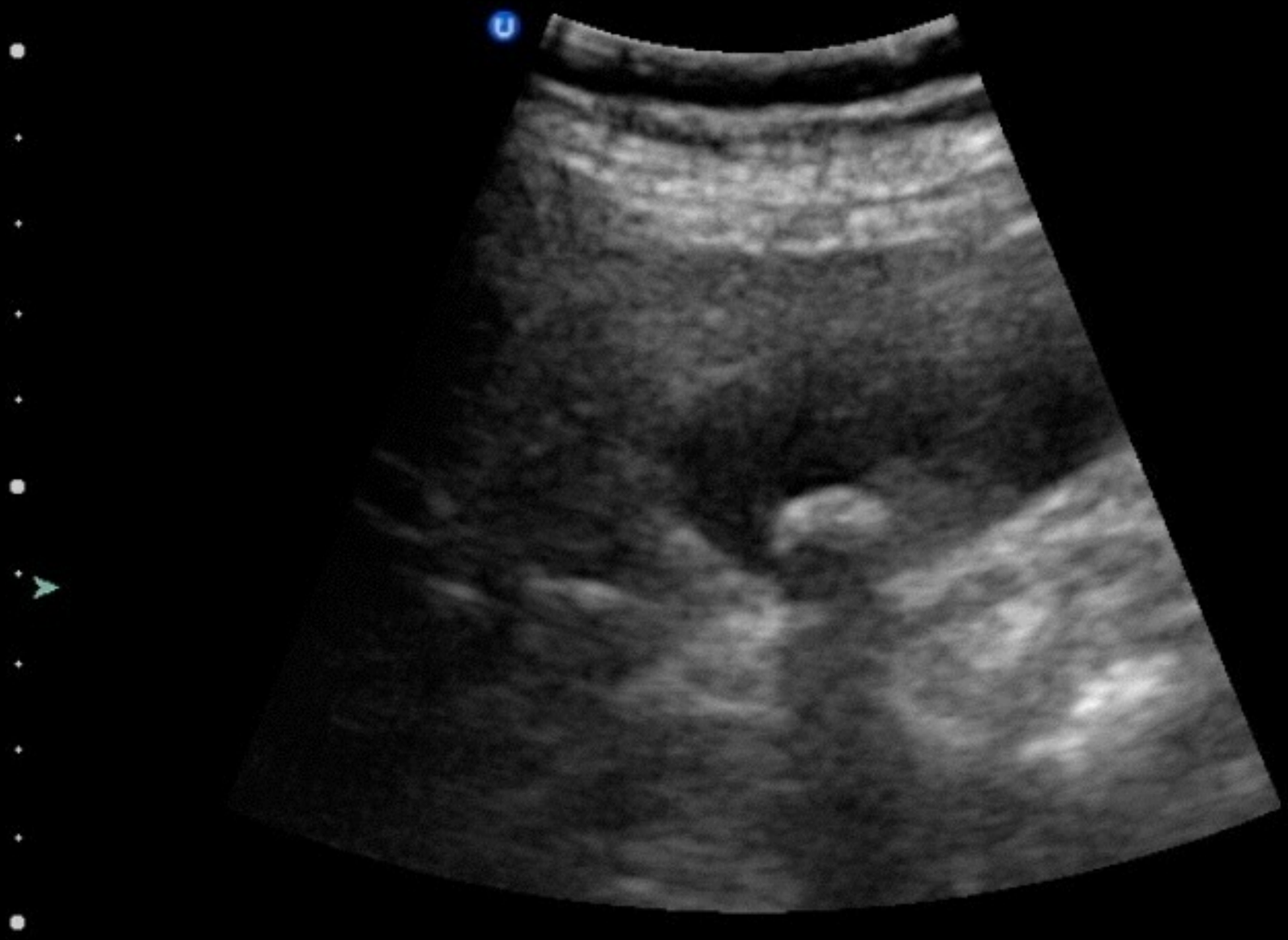
- sonographic features
  - echogenic structures within an echo-free gallbladder lumen
  - acoustic shadows with “clean” margins
  - gravitationally dependent
  - are usually mobile

Sonographic Pathology

Cholelithiasis

Sonographic Pathology

Cholelithiasis

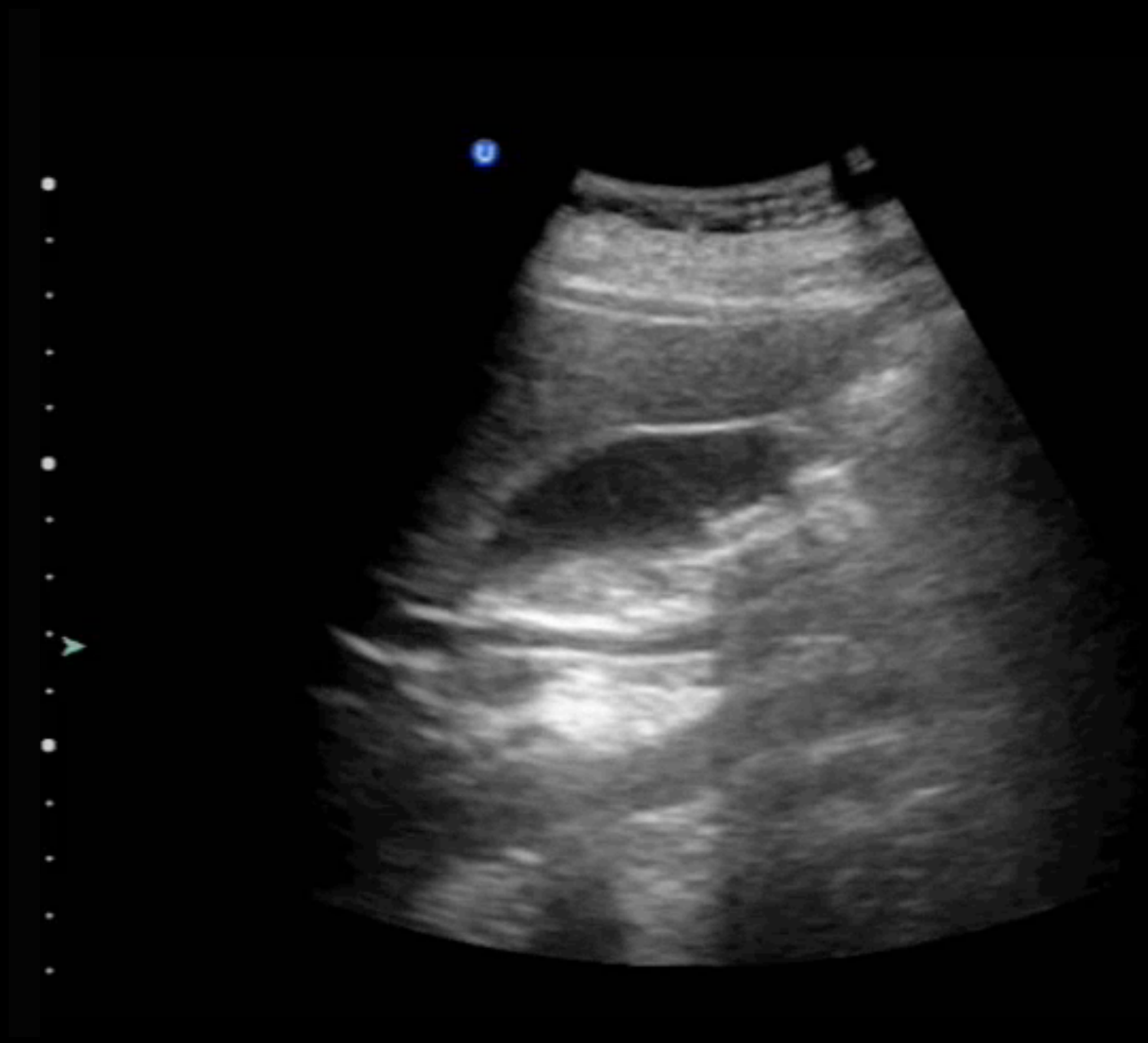


Sonographic Pathology

Cholelithiasis

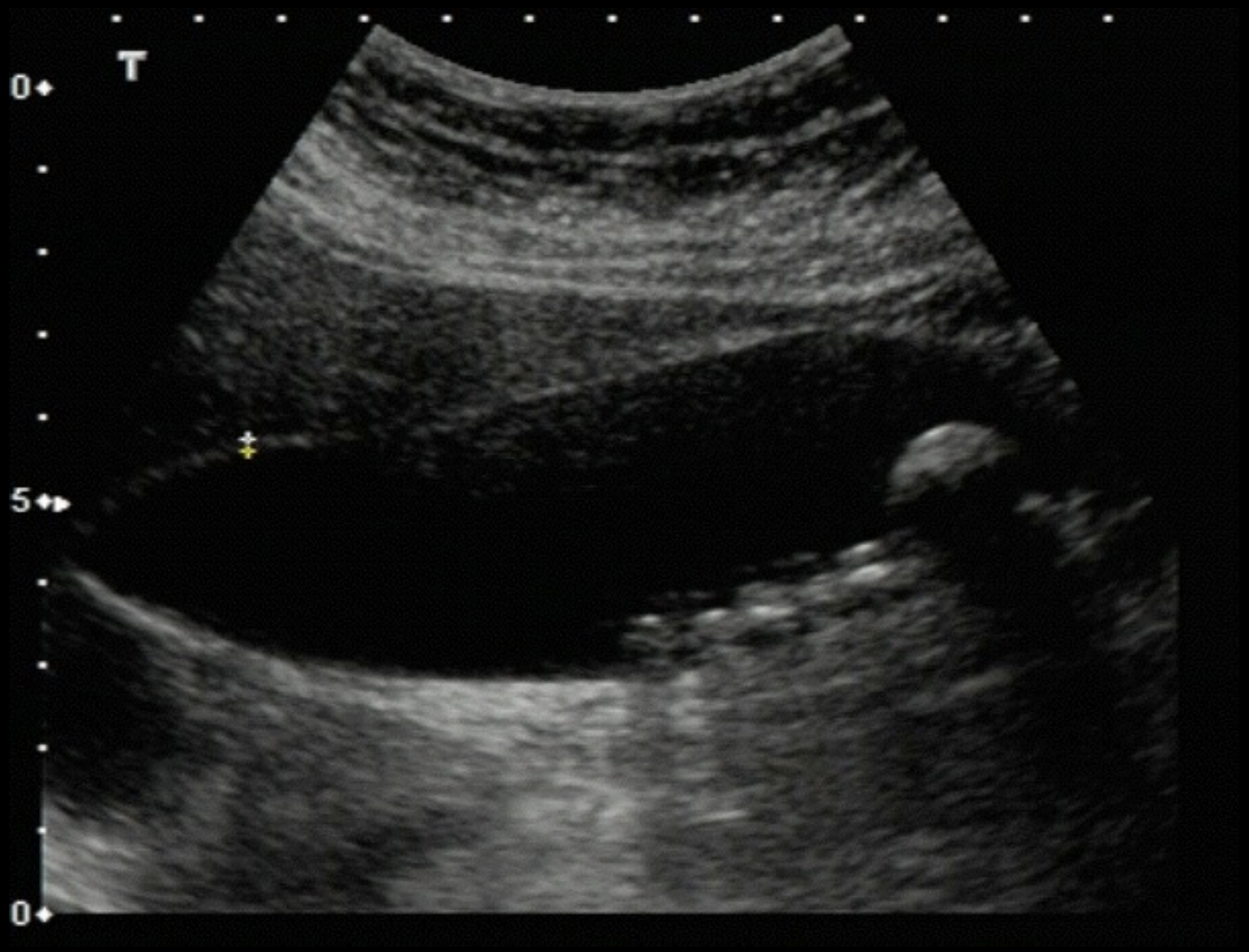
Sonographic Pathology

Cholelithiasis



Sonographic Pathology

Cholelithiasis

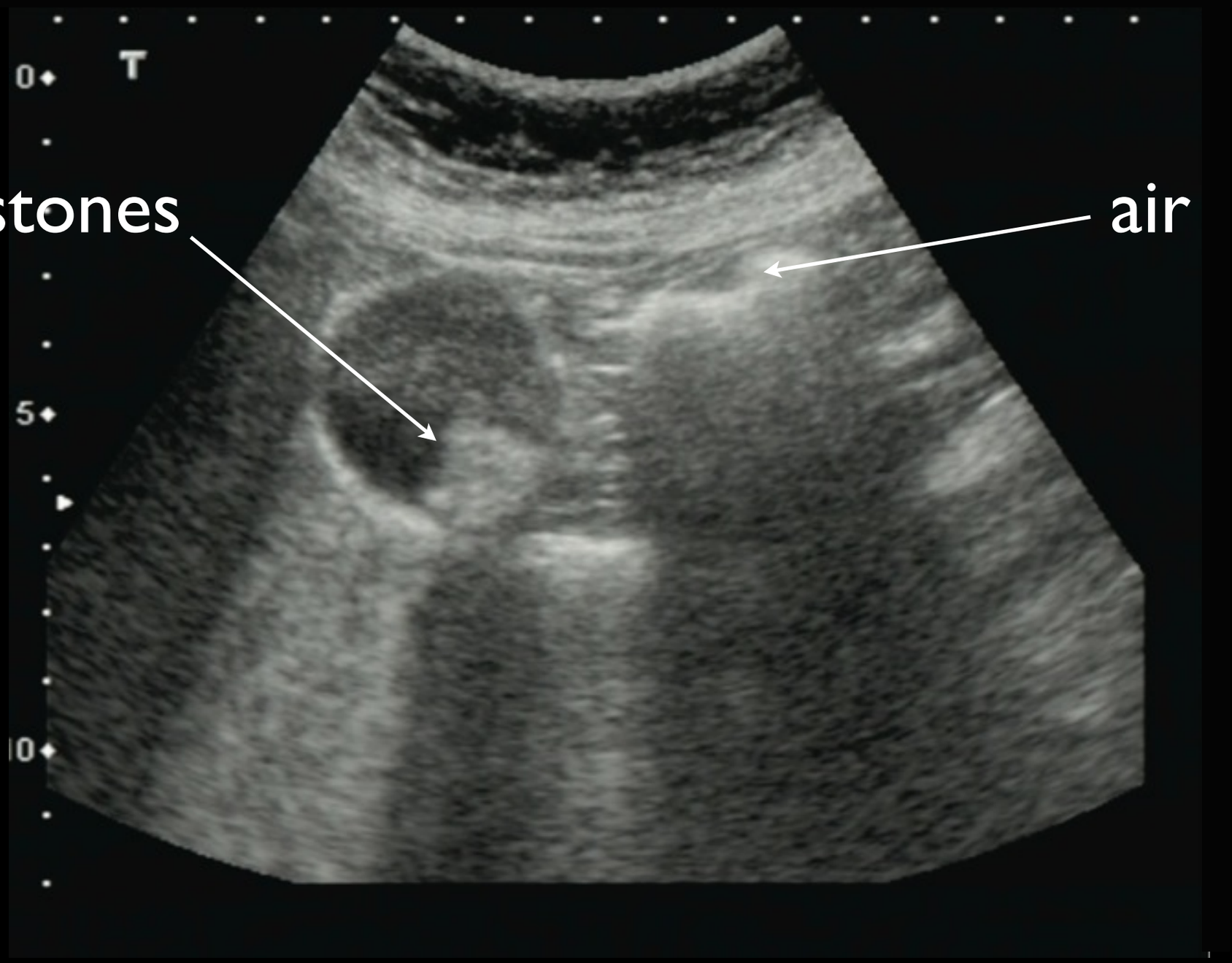


Sonographic Pathology

Cholelithiasis

bowel gas

Cholelithiasis



Sonographic Pathology

Cholelithiasis

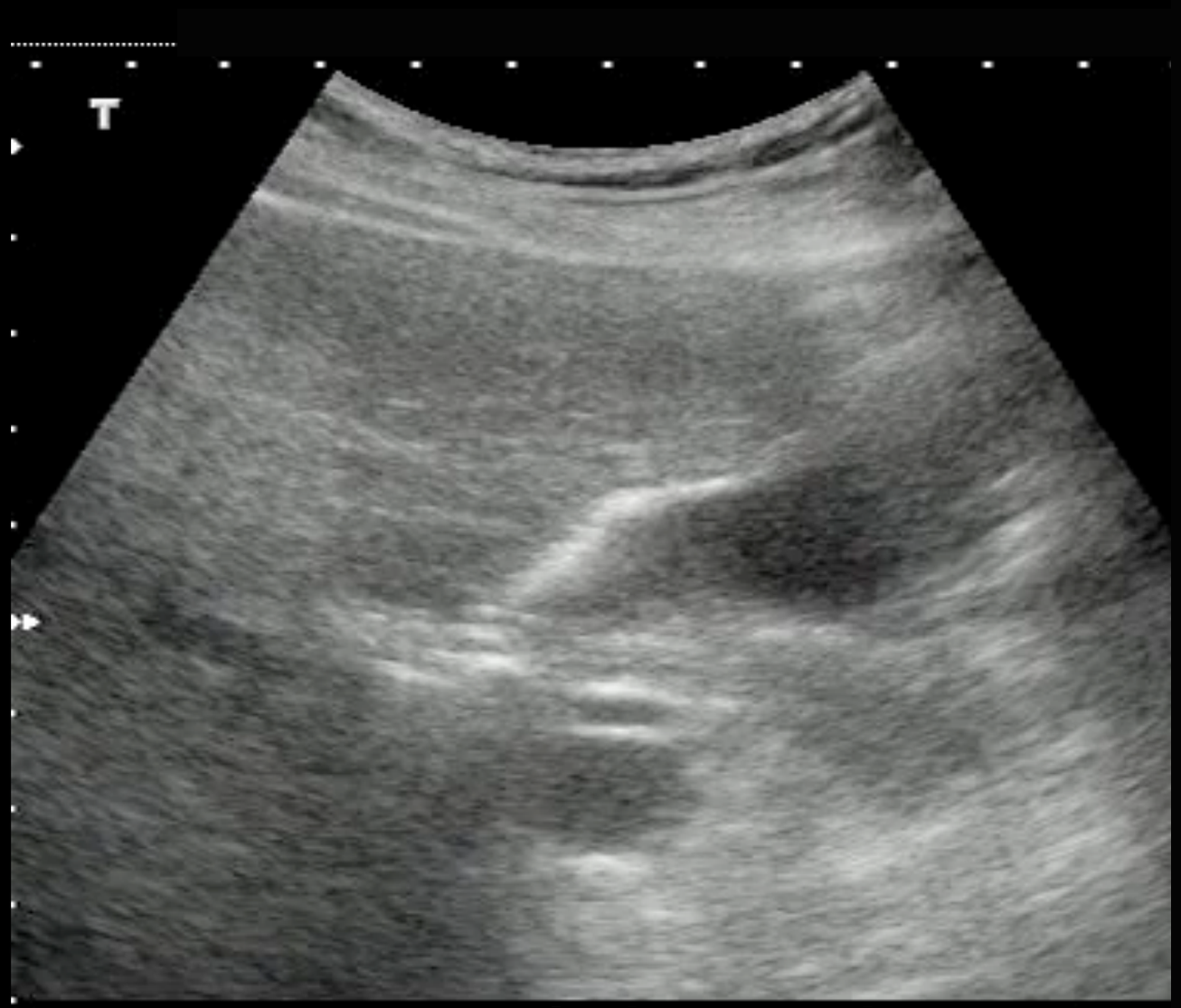
gravel

Sonographic Pathology

Cholelithiasis

Sonographic Pathology

Cholelithiasis

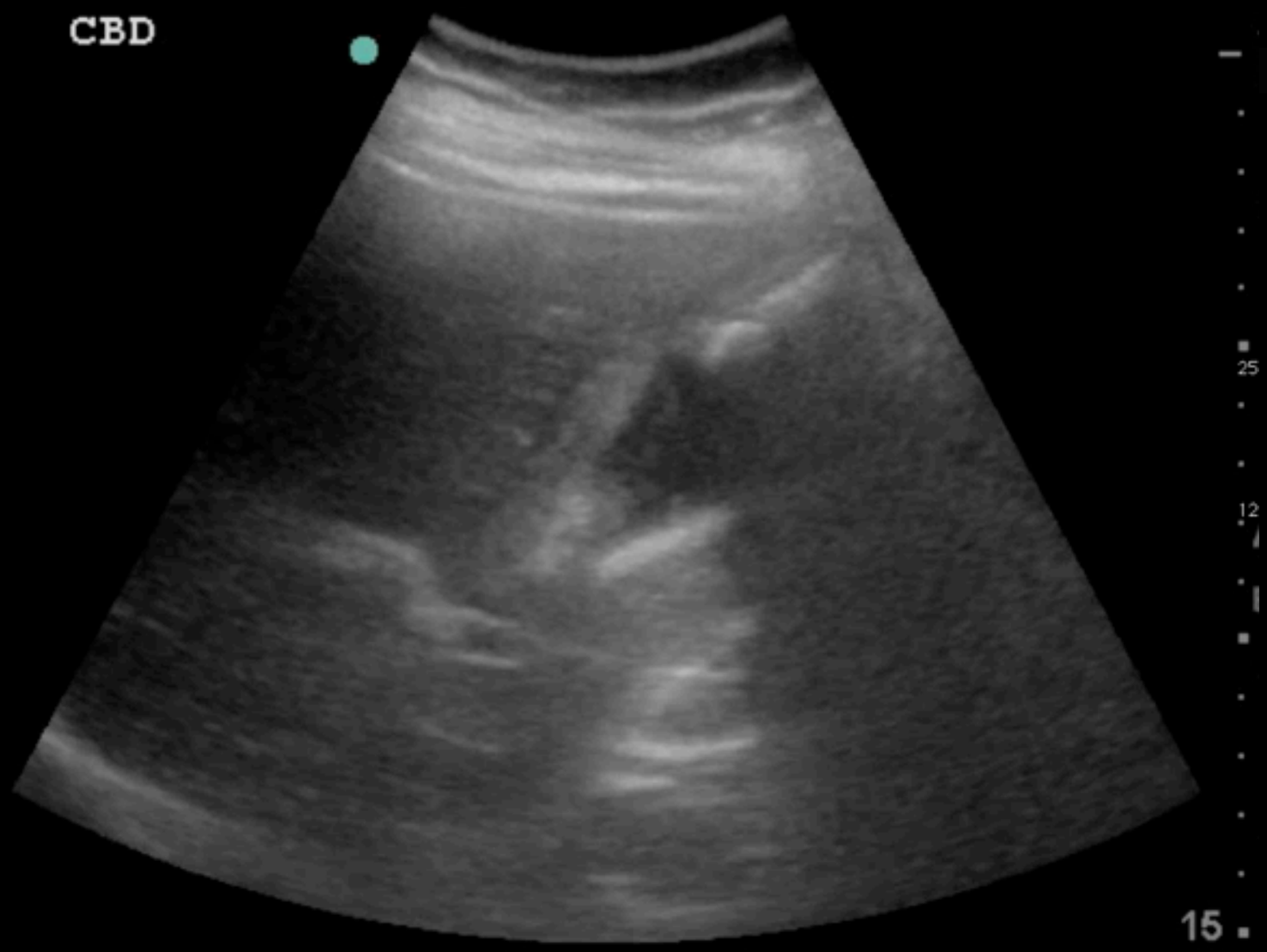


gravitational dependence

Maneuver: patient turned while gallbladder kept in view

Sonographic Pathology

Cholelithiasis

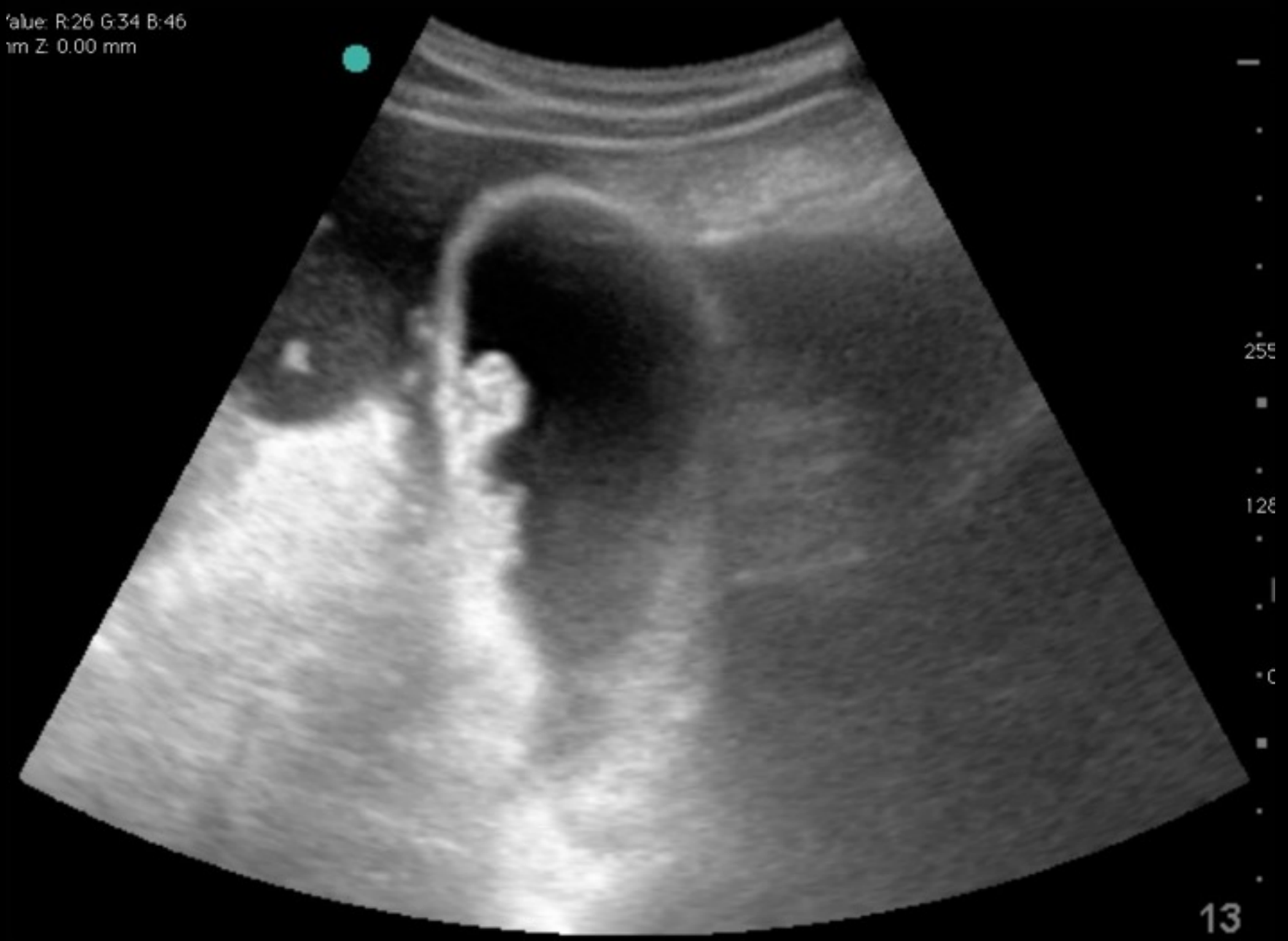


Maneuver: patient turned while gallbladder kept in view

gravitational dependence

Sonographic Pathology

Cholelithiasis



Gallbladder polyp: not gravitationally dependent

Cholelithiasis

- gallbladder filled with stones: "Wall Echo Sign"
- strong hyperechoic anterior rim of gallstones
- difficult for novice to identify
- may confuse with bowel gas

Sonographic Pathology

Cholelithiasis

almost WES

Sonographic Pathology

Cholelithiasis

wall echo sign

Sonographic Pathology

Cholelithiasis

not a wall echo sign

Cholelithiasis

- image patterns
  - echogenic focus, “clean” acoustic shadow, gravitational dependence
  - gravel
  - large stone
  - wall echo sign

Sonographic Pathology

Cholecystitis

Gallbladder disease exists along a continuum

asymptomatic cholelithiasis

↓

biliary colic

↓

acute cholecystitis

Cholecystitis

- Signs and symptoms
  - Fever and chills
  - Right upper quadrant pain
  - Leukocytosis
  - Murphy's sign
  - Jaundice

Cholecystitis

stone lodges in cystic or CBD

↓

increased intraluminal pressure

↓

distention of the hollow viscus (pain, nausea, vomiting)

↓

gallbladder wall thickening, edema

↓

pericholecystic fluid

Cholecystitis

- aseptic inflammation
- bacterial infection
- gangrene with or without perforation

Cholecystitis

- complications of acute cholecystitis
  - gangrenous cholecystitis
  - gallbladder wall perforation
  - pericholecystic abscess
  - sepsis
  - peritonitis
  - ascending cholangitis
  - peritoneal abscess
  - cholecystoenteric fustual

Cholecystitis

- Sonographic Findings of Cholecystitis:
  - Cholelithiasis
  - Gallbladder wall thickening
  - Pericholecystic fluid
  - Sonographic Murphy's sign

Cholecystitis

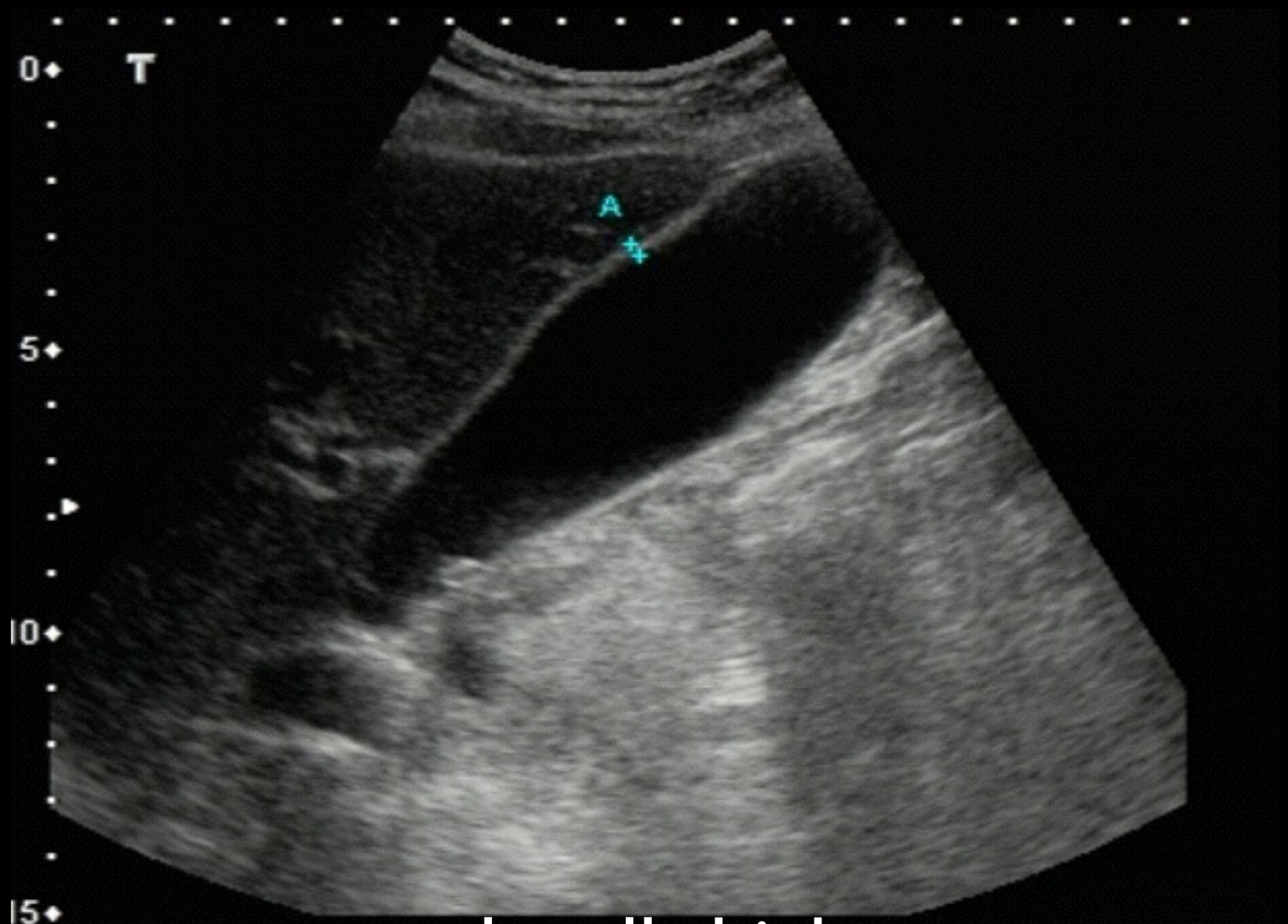
- cholelithiasis
- found in the majority of cases
- if absent, look for acalculous cholecystitis

Cholecystitis

- anterior wall thickness <4mm
  - average is 9mm in acute cholecystitis
- may be thicker in other processes:
  - normal post-prandial contraction
  - hypoalbuminemia
  - hepatitis
  - ascites
  - heart failure

Sonographic Pathology

Cholecystitis



normal wall thickness

Sonographic Pathology

Cholecystitis

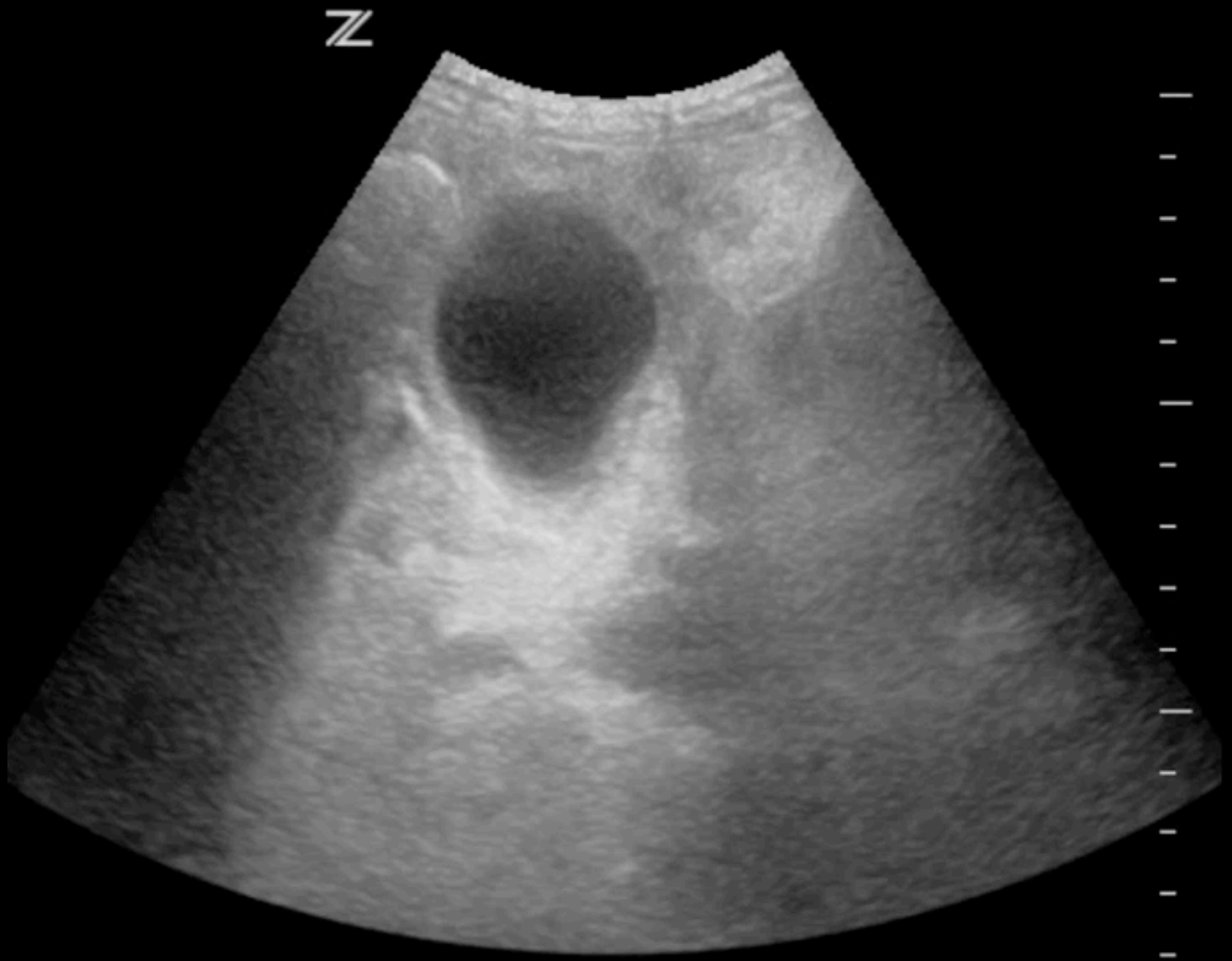
Sonographic Pathology

Cholecystitis

wall thickening

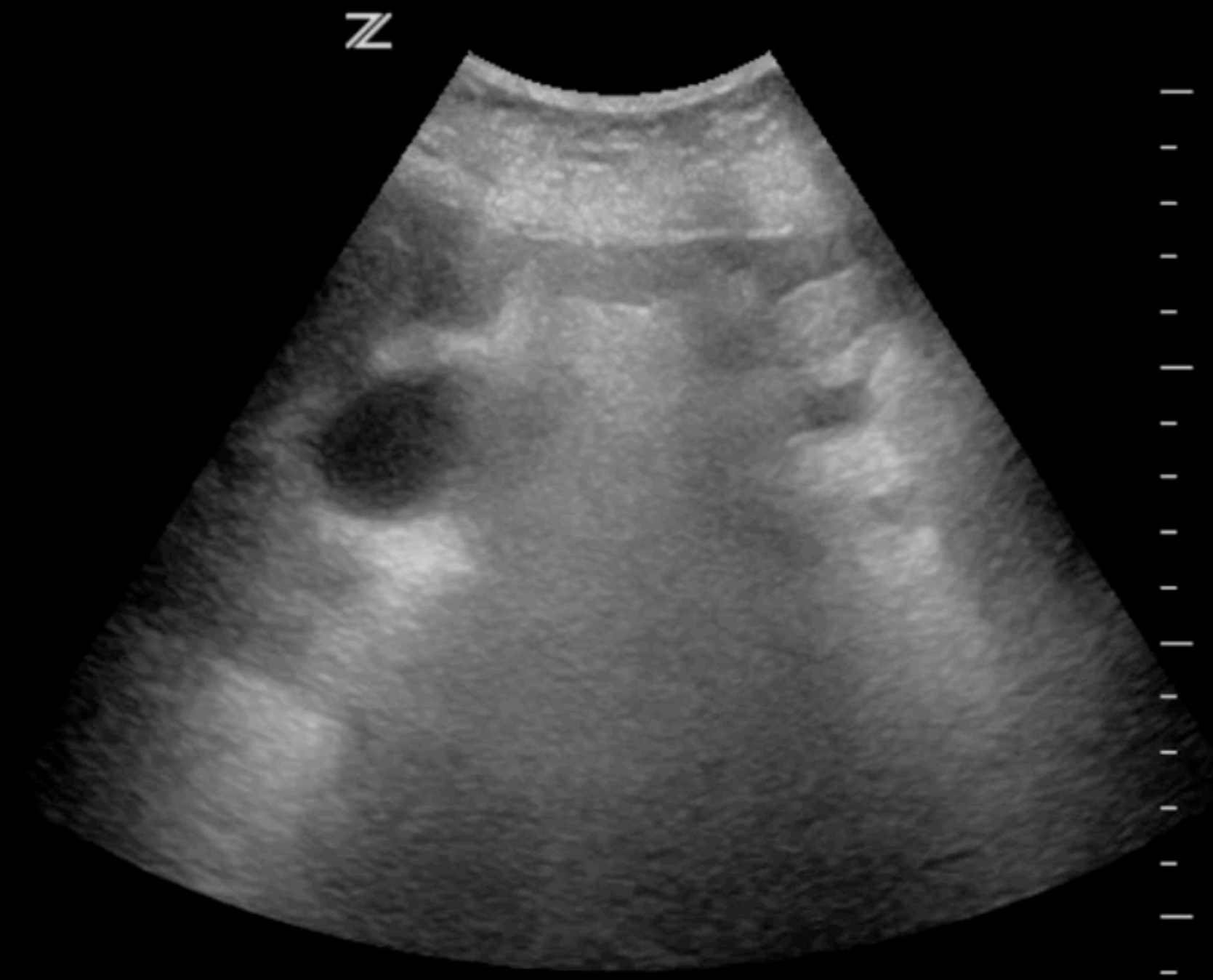
Sonographic Pathology

Cholecystitis



Sonographic Pathology

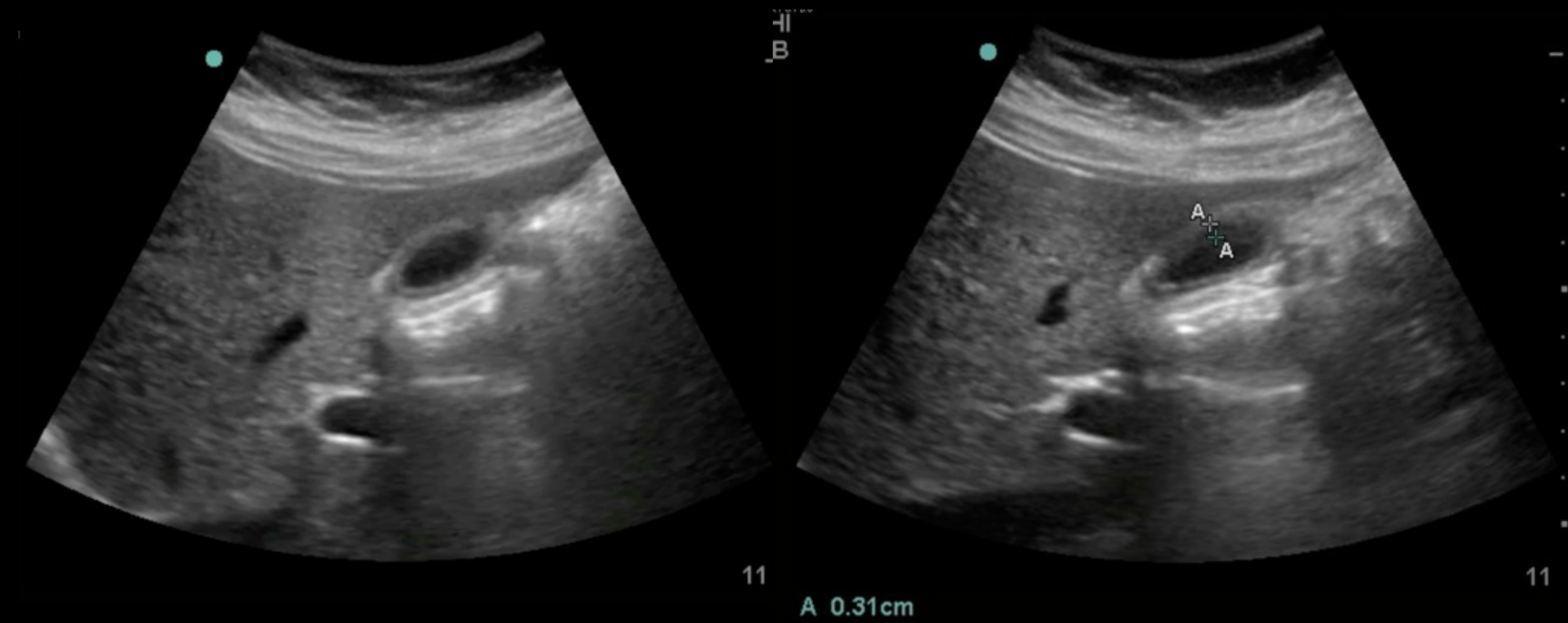
Cholecystitis



Ascites causing wall thickening

Sonographic Pathology

Cholecystitis



postprandial contraction

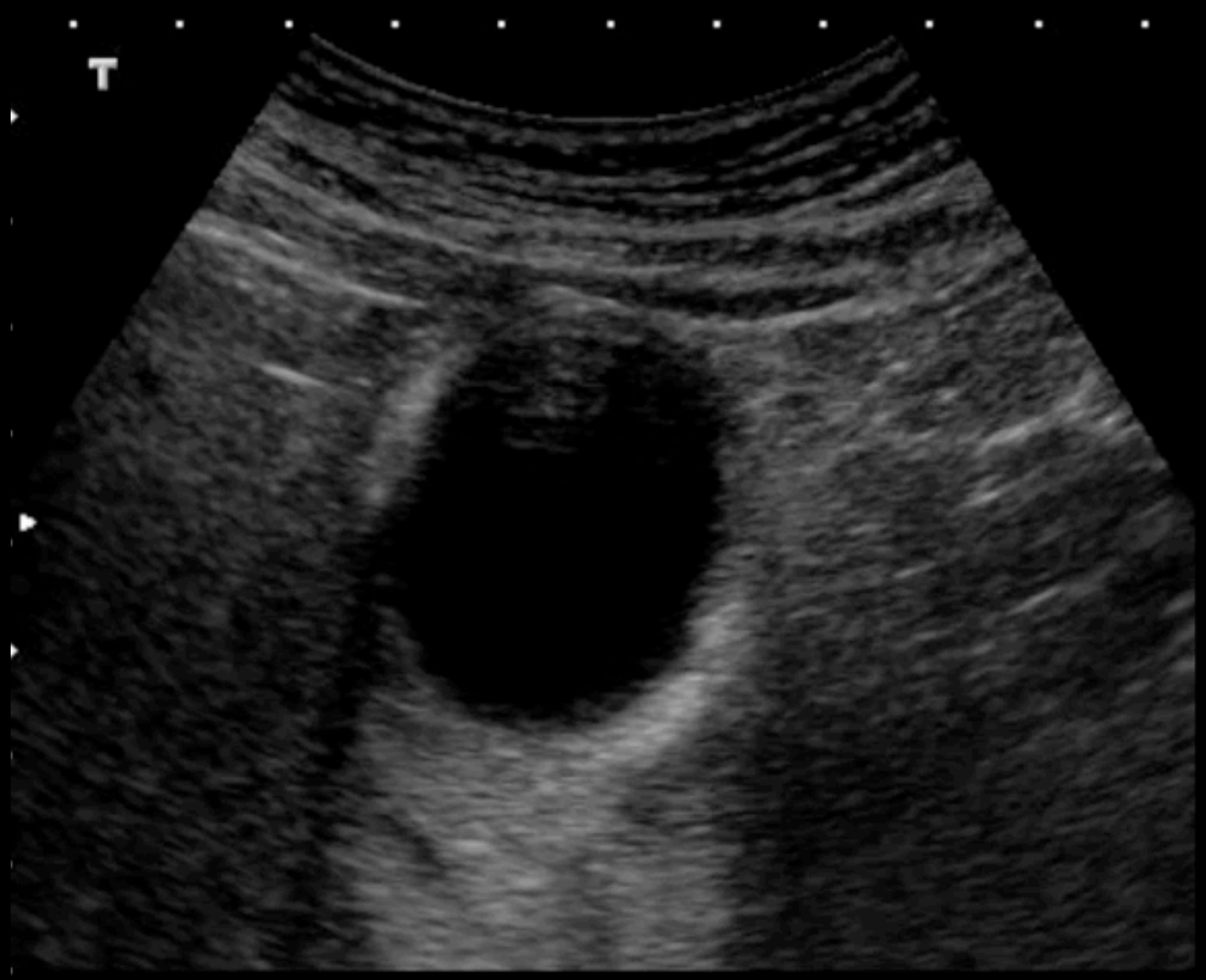
Cholecystitis

- ultrasonographic Murphy's sign
- fairly sensitive indicator
- sensitivity 72-93%
- specificity 35%

Cholecystitis

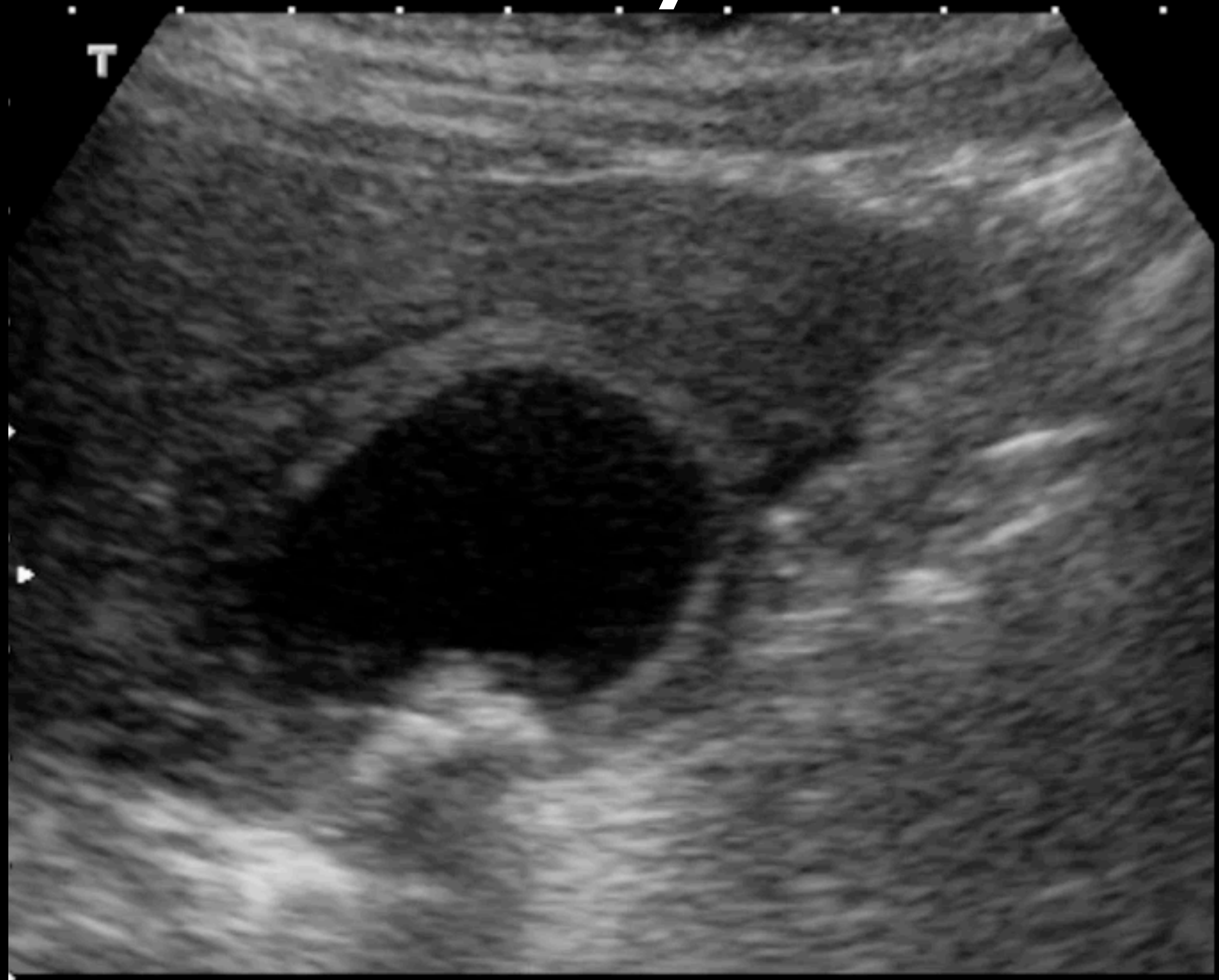
- pericholecystic fluid
  - “weeping” of serous fluid from surface of gallbladder
  - my represent perforation or abscess

Cholecystitis



pericholecystic fluid

Cholecystitis



pericholecystic fluid

Cholecystitis

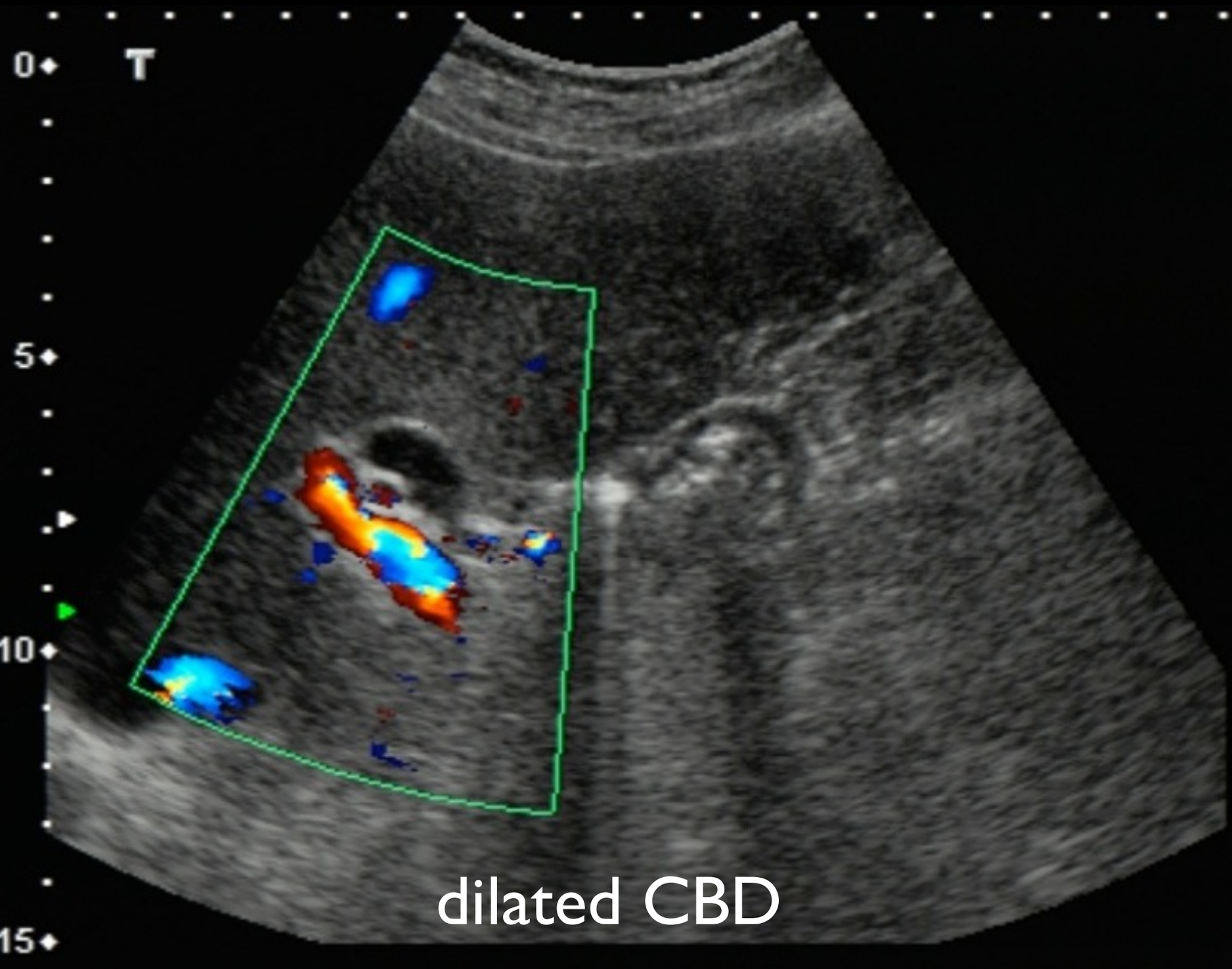
- Enlarged common bile duct
  - may be difficult for the novice
  - turn patient on left side
  - transducer perpendicular to costal margin
  - superior to portal vein

Cholecystitis

- Common Bile Duct
  - average internal diameter is 4-6mm
  - greater than 7mm is abnormal
  - CBD > 1cm is indicative of obstruction
  - look for duct stones

Sonographic Pathology

Cholecystitis



Cholecystitis

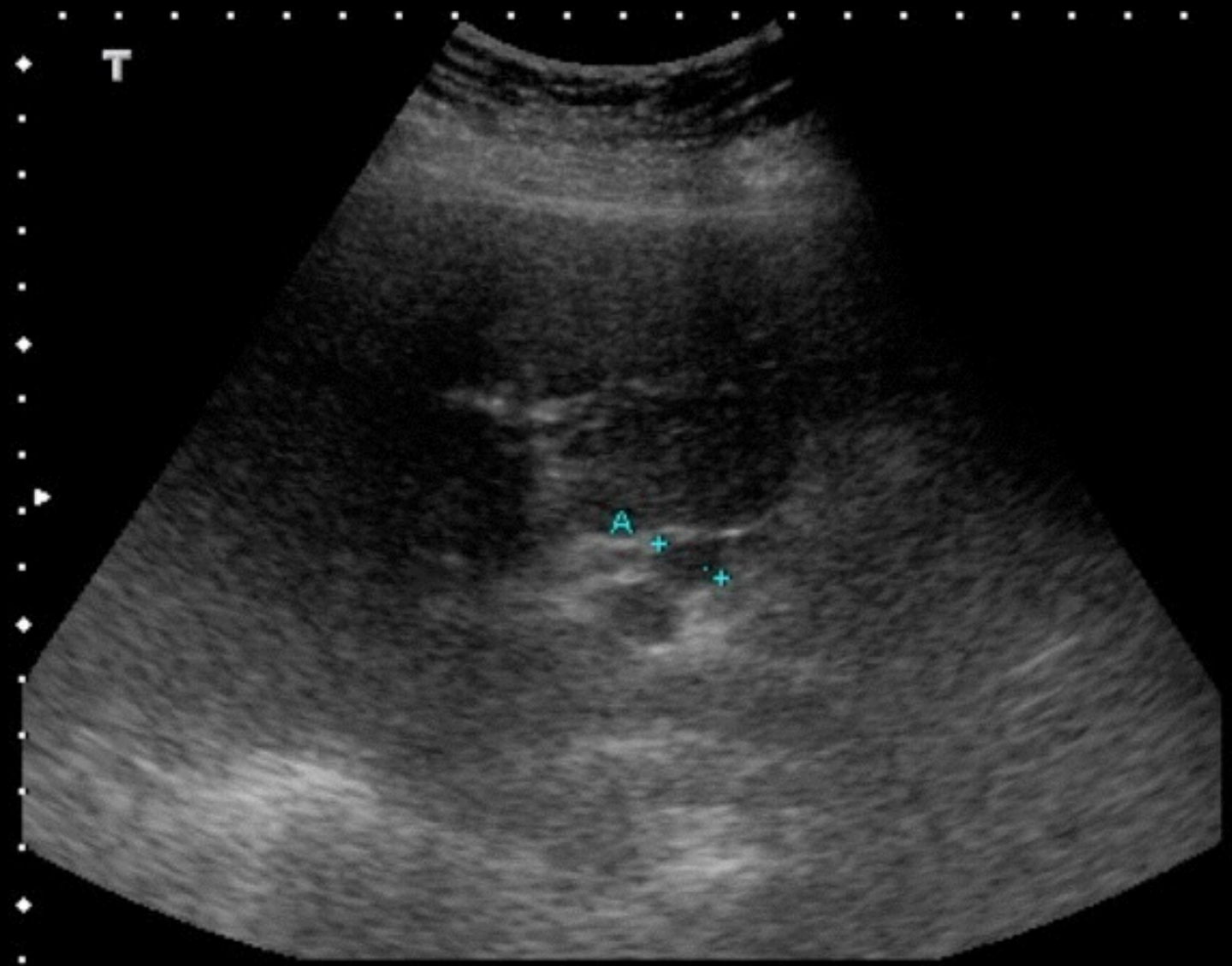
dilated CBD

Cholecystitis

dilated CBD

Sonographic Pathology

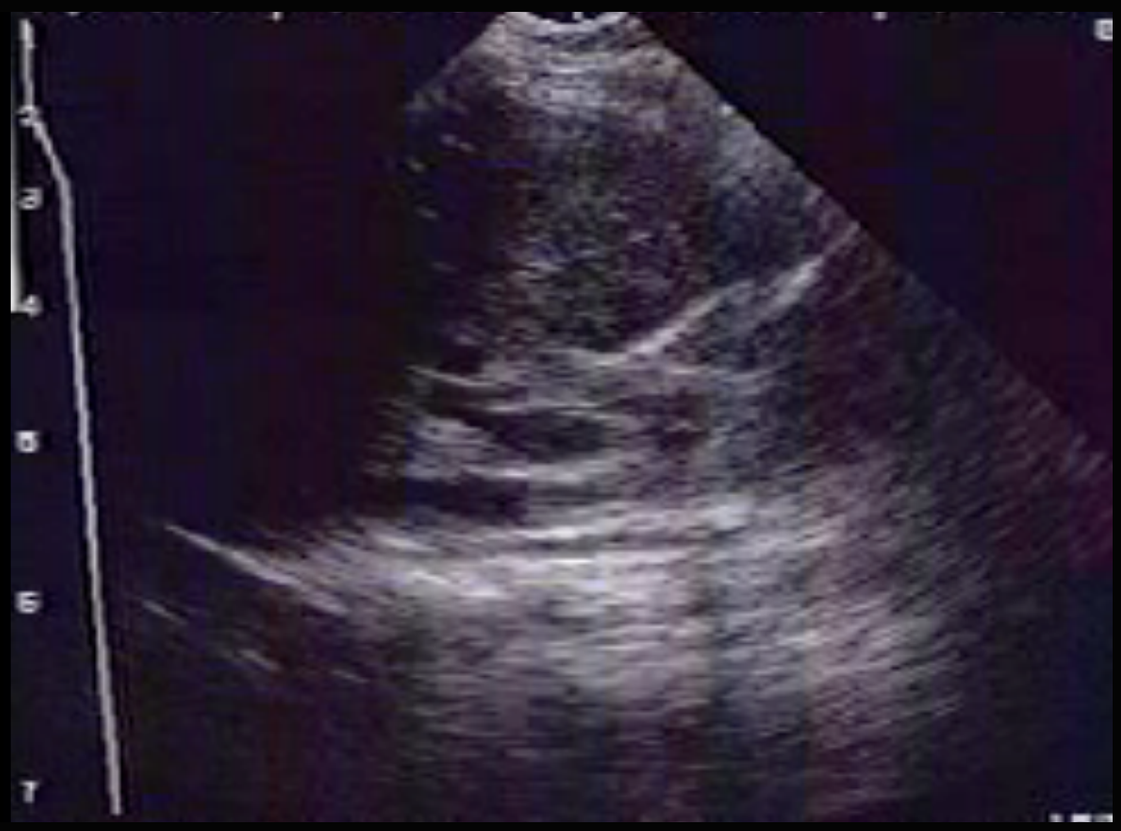
Cholecystitis



Cholecystitis

dilated CBD

Cholecystitis



enlarged CBD with duct stone

Gallbladder Sludge

- clinical significance is controversial
- presence may be associated with:
  - extrahepatic biliary tract obstruction
  - acute or chronic cholecystitis
  - pancreatitis
  - relatively benign stasis of bile

Gallbladder Sludge

- found in approximately 2% of RUQ ultrasounds
- clinical course
  - most often resolves spontaneously
  - may lead to biliary tract pathology

Gallbladder Sludge

- what to do with "sludge?"
- if incidental ⟶ follow
- if found in the presents of acute symptomology or...
  - thickened gallbladder wall
  - pericholecystic fluid
  - sonographic Murphy's sign

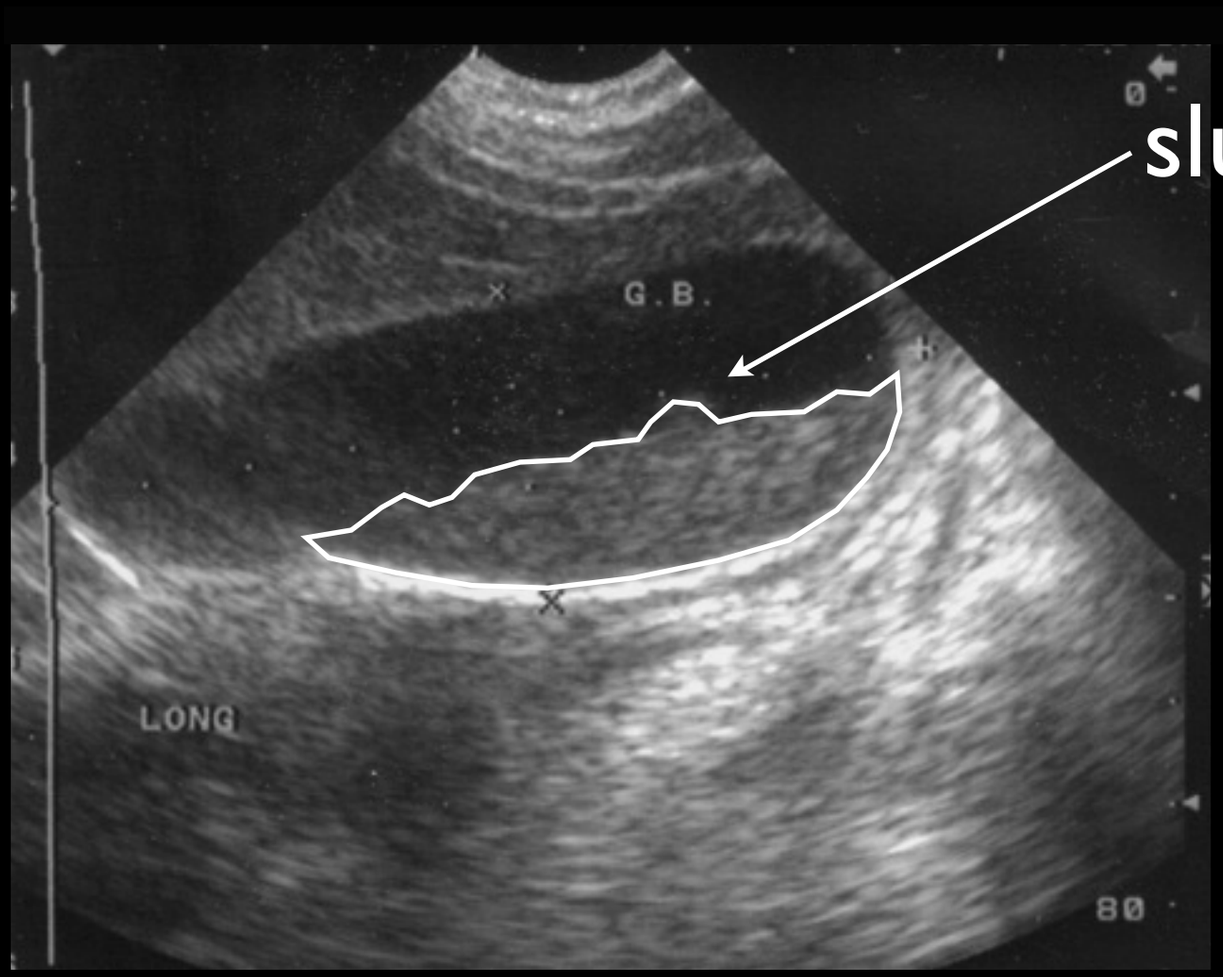
treat aggressively

Gallbladder Sludge

- low amplitude intraluminal echo
- exhibits dependency
- may appear to contain stones

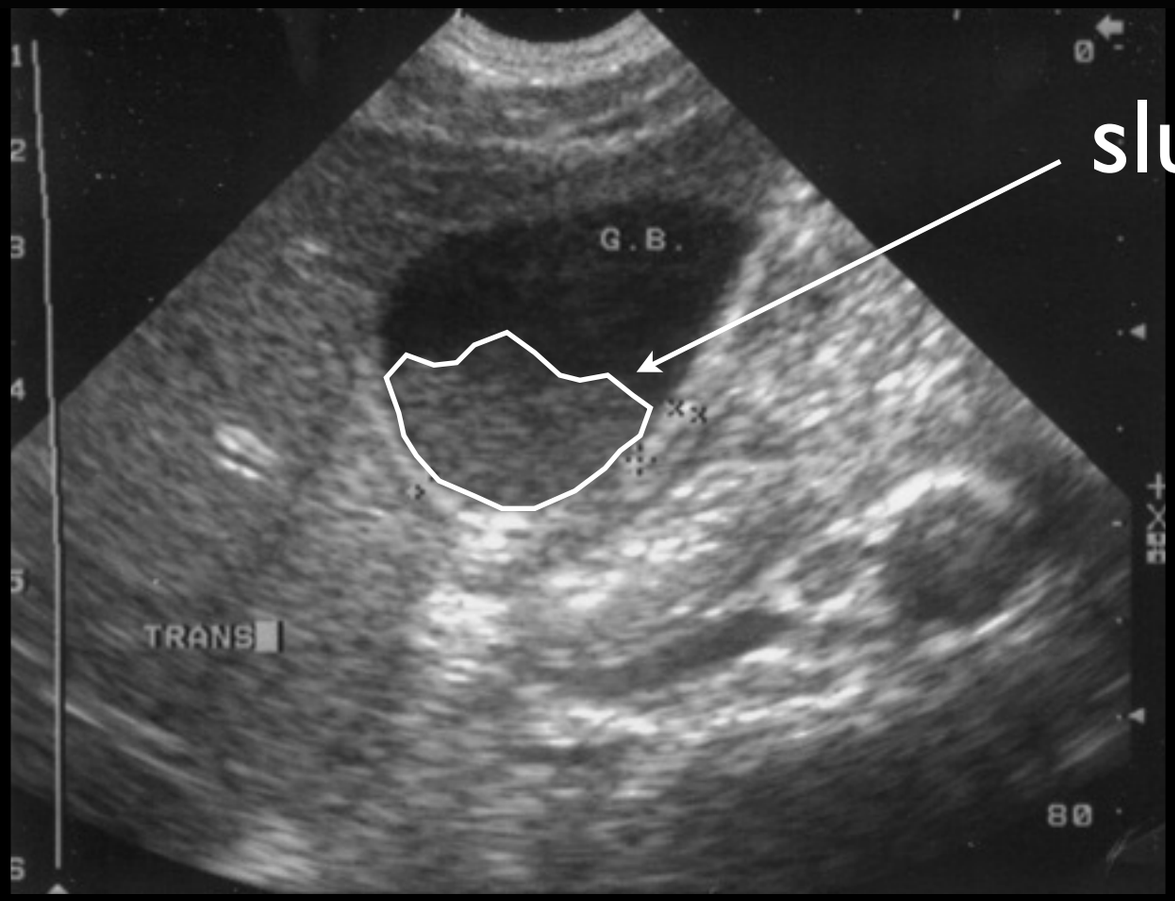
Sonographic Pathology

Gallbladder Sludge



Sonographic Pathology

Gallbladder Sludge



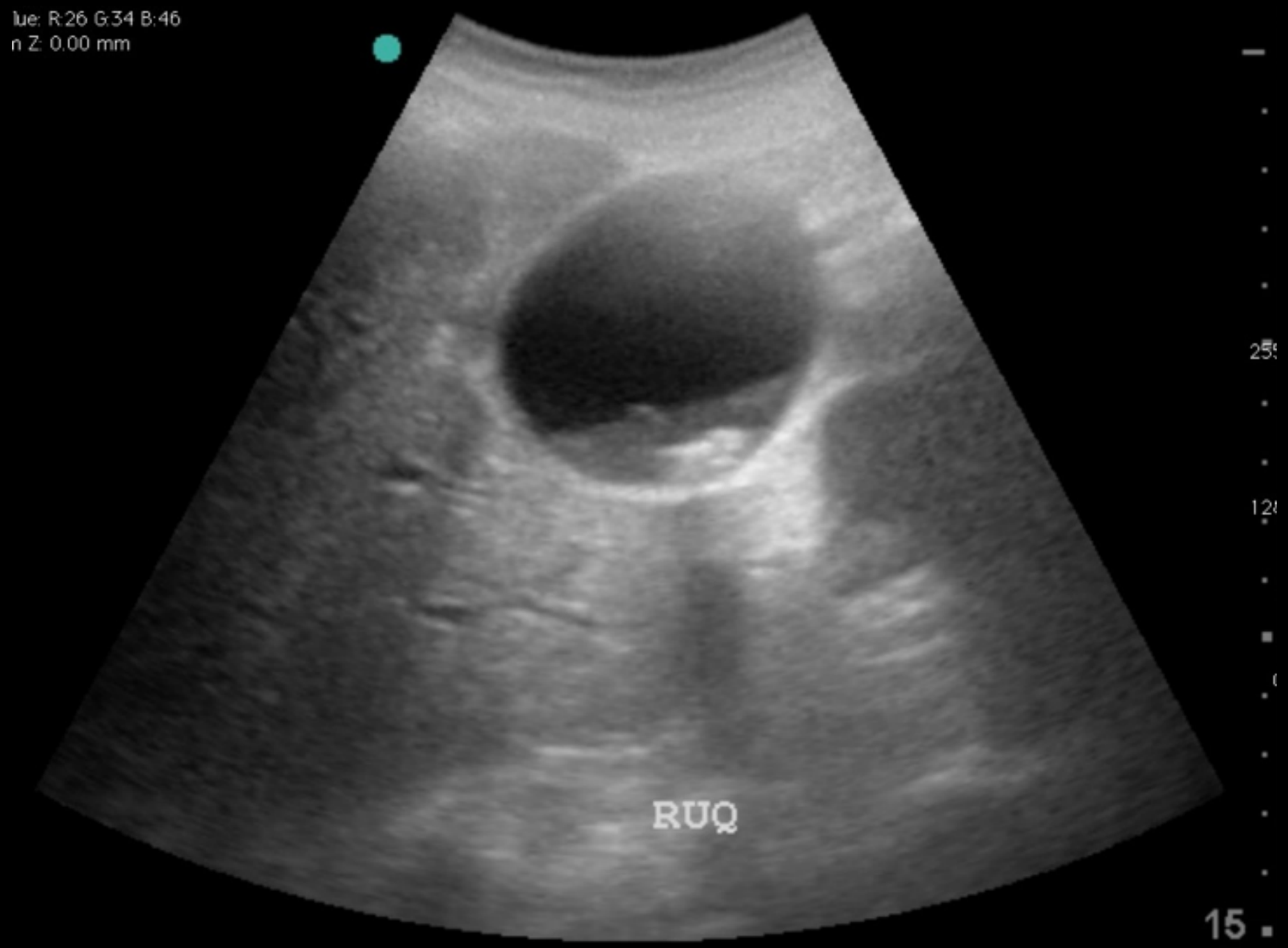
Sonographic Pathology

Gallbladder Sludge

sludge with internal gallstones

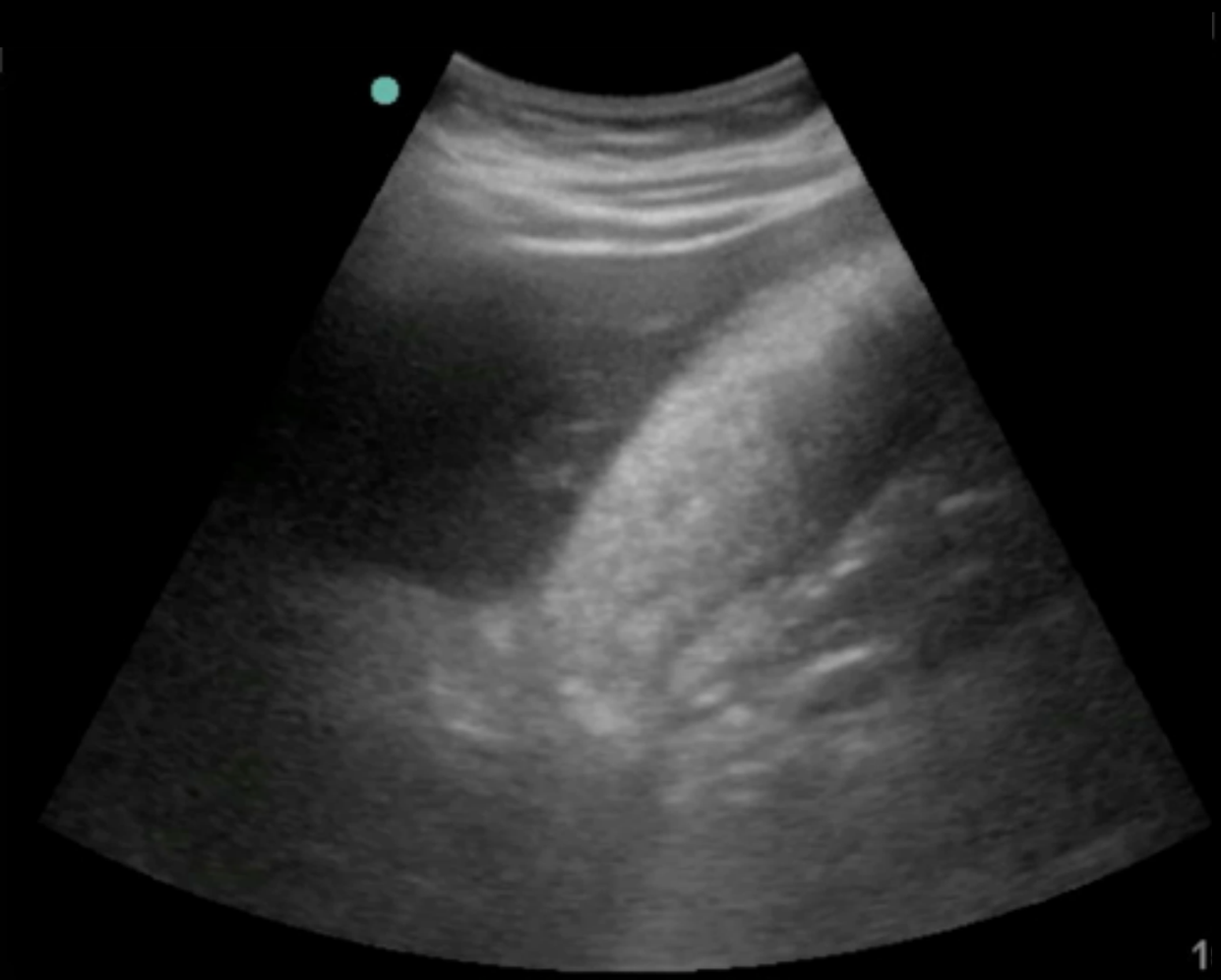
Sonographic Pathology

Gallbladder Sludge



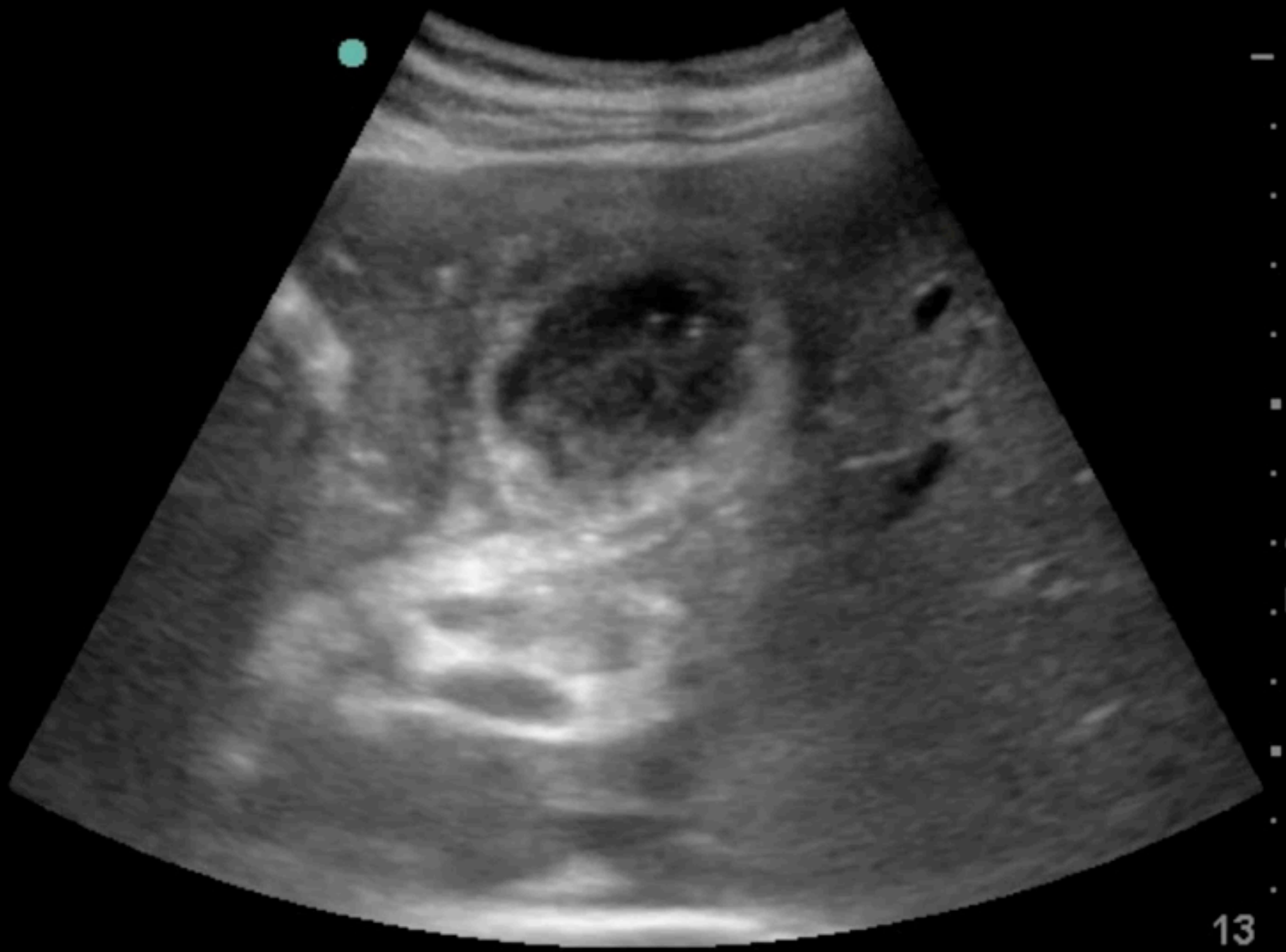
Sonographic Pathology

Abscess/Perforation



Sonographic Pathology

Abscess/Perforation



Acalculous Cholecystitis

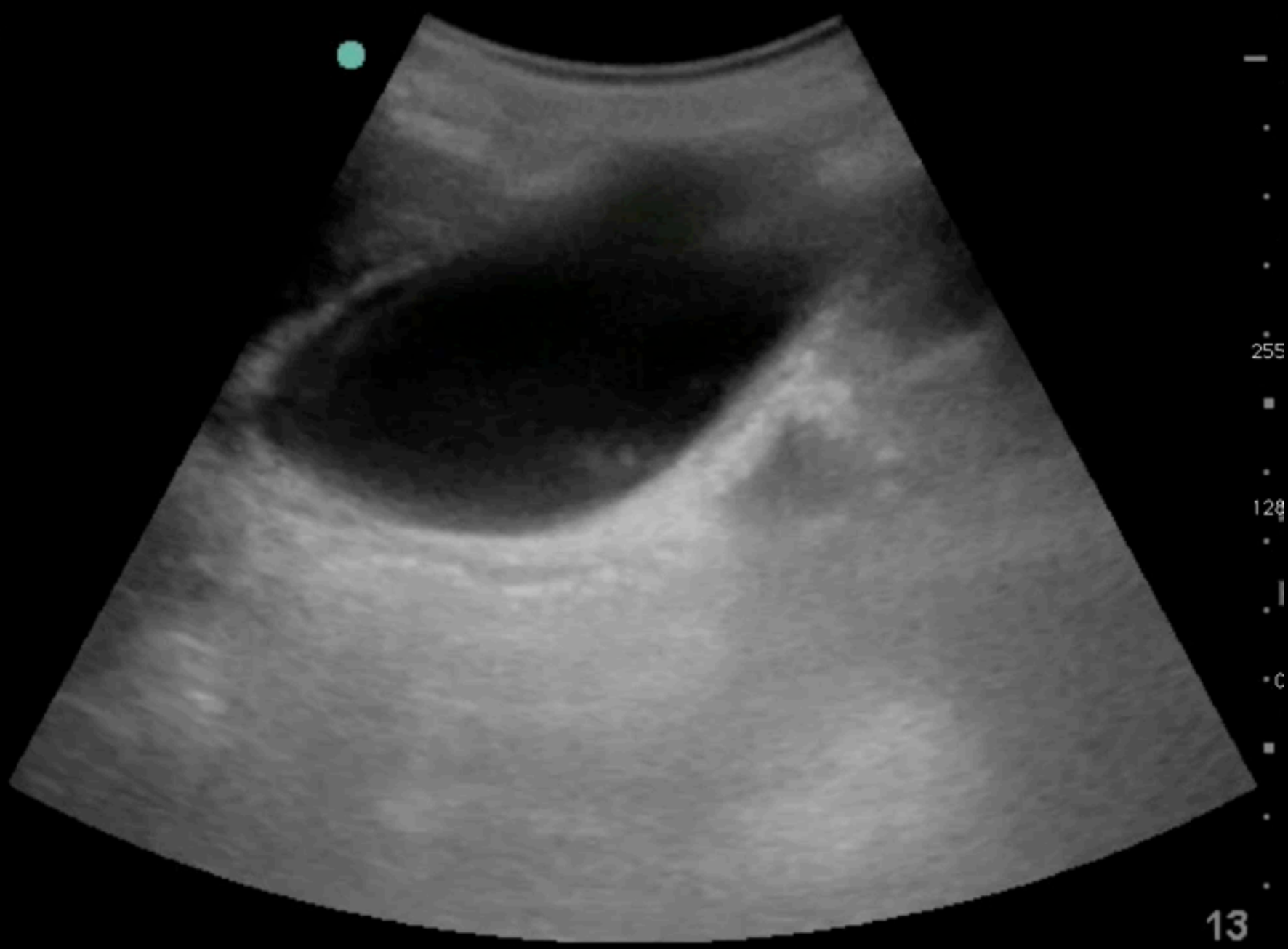
- 5-10% of acute cholecystitis
- more rapid, malignant course
- ultrasound shows cholecystitis without gallstones

Acalculous Cholecystitis

- patients usually very ill on presentation
- frequently occurs as complication of another process:
  - multiple trauma
  - extensive burns
  - prolonged labor
  - major surgery
  - biliary tract infections

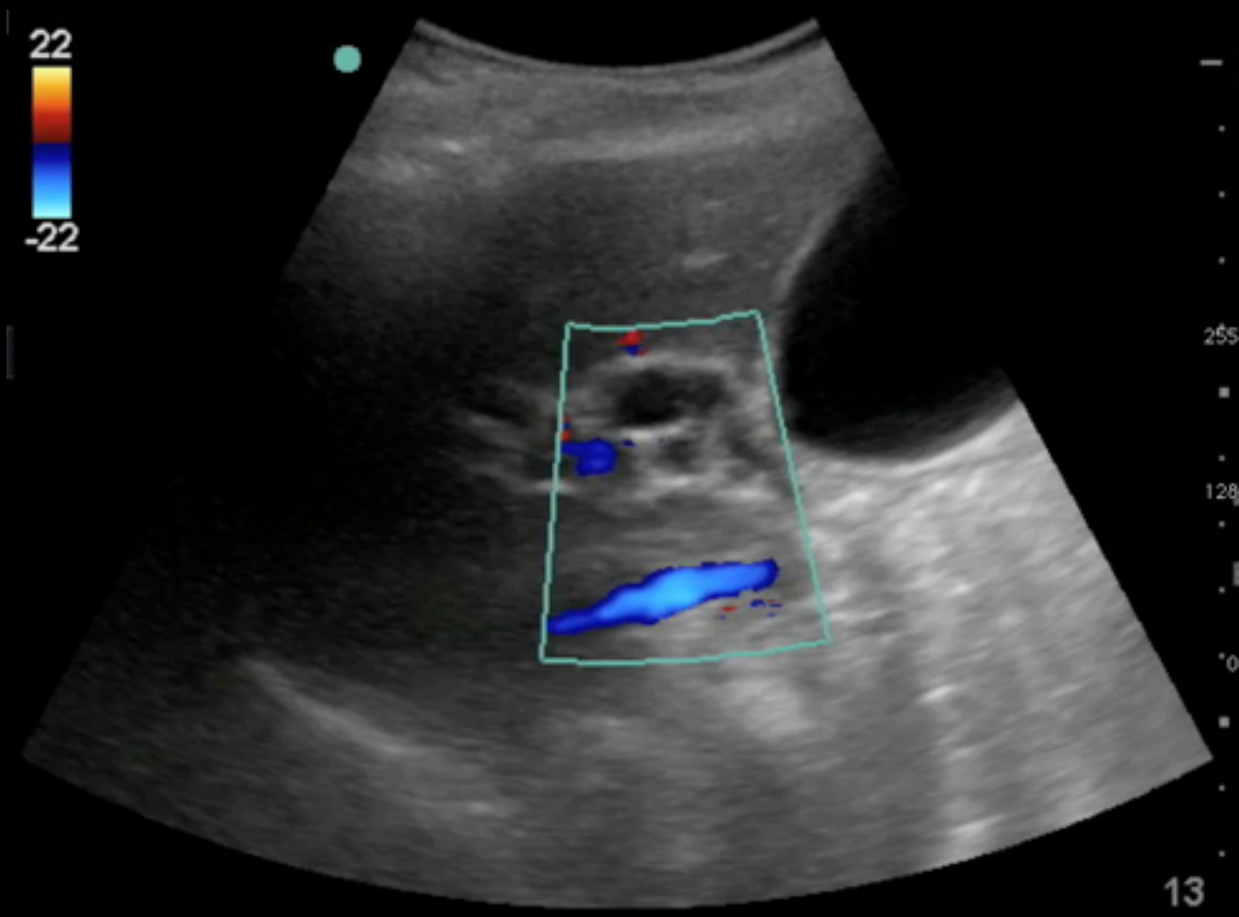
Sonographic Pathology

Acalculous Cholecystitis



Sonographic Pathology

Acalculous Cholecystitis

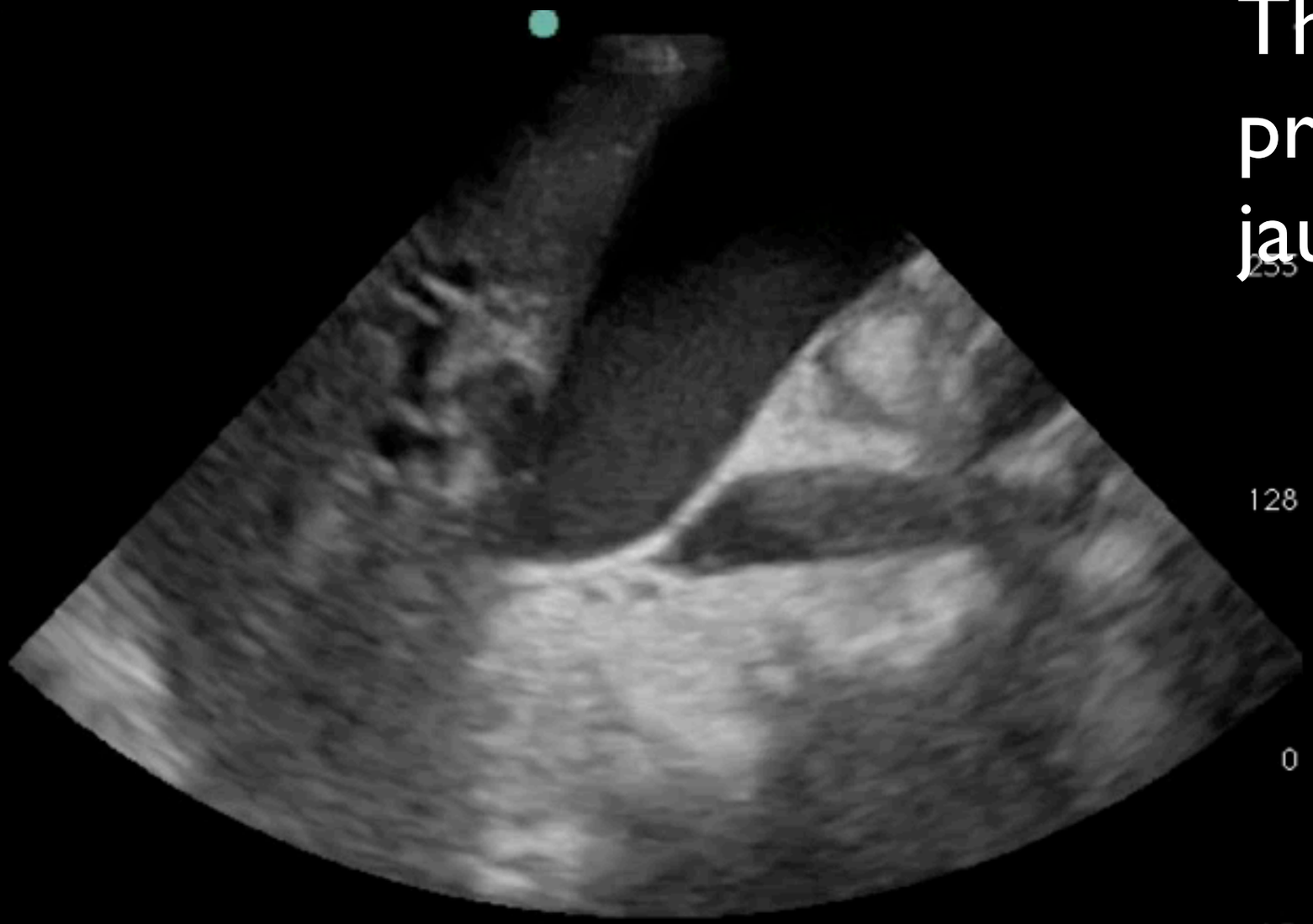


Jaundice

- obstructive vs non-obstructive
- may determine need for
- specialty consultation or intervention
- urgency of further treatment
- admission

Sonographic Pathology

Jaundice

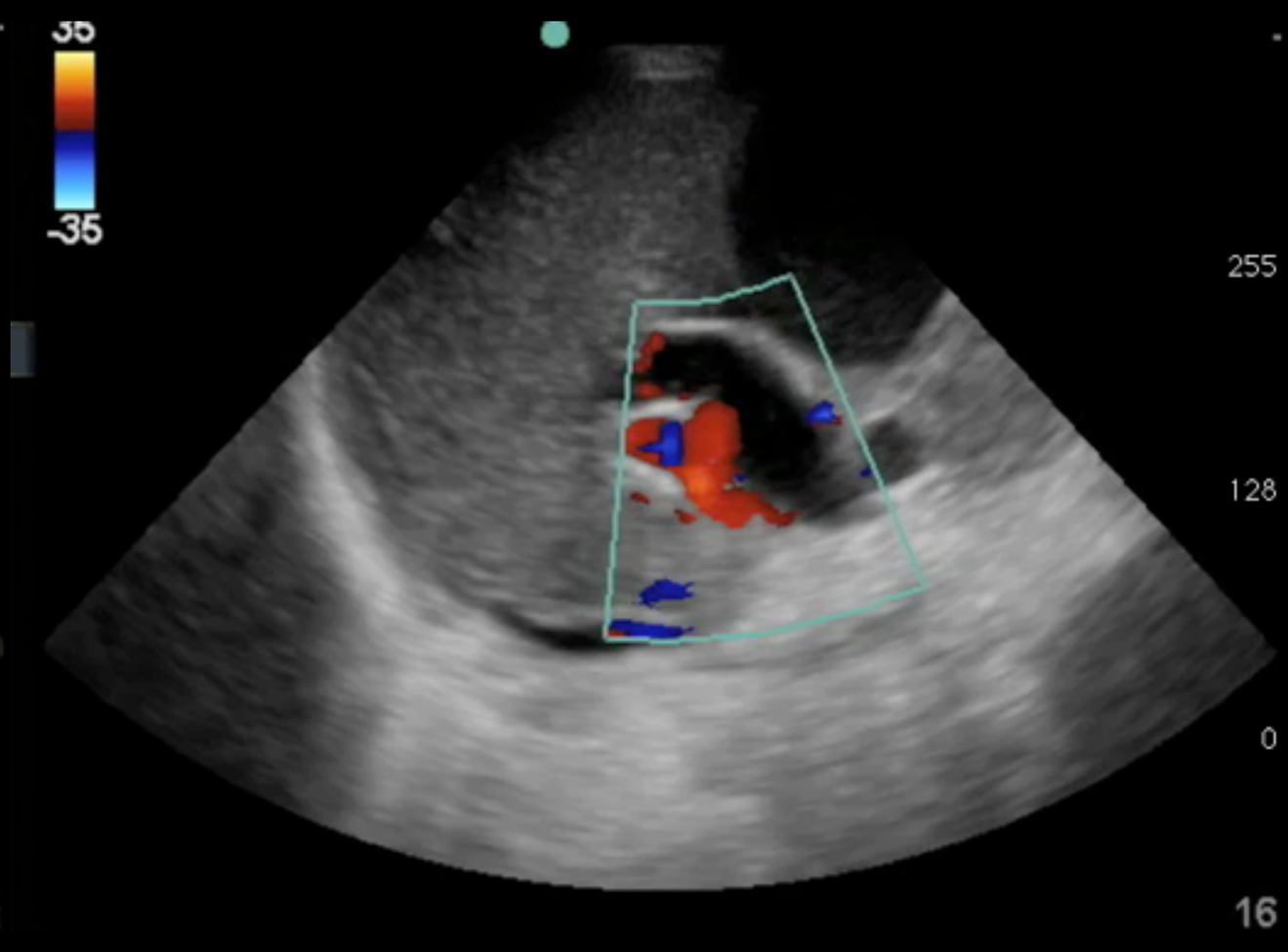


This 78 y/o male presented with painless jaundice

cystic duct dilatation

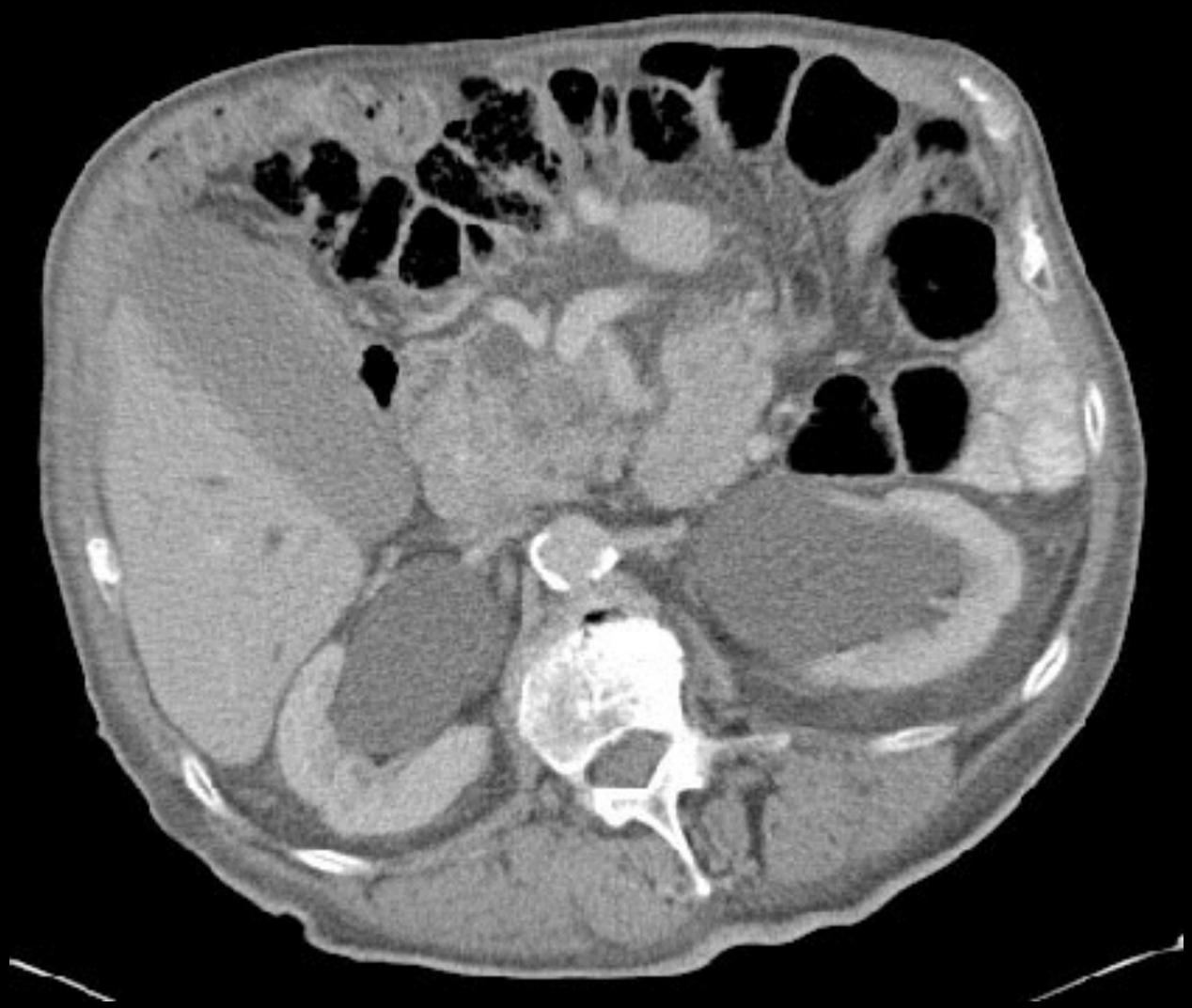
Sonographic Pathology

Jaundice



CBD dilated

Jaundice



pancreatic cancer

Gallbladder Cancer

- primary carcinoma of the gallbladder
- most common malignancy of the biliary tract
- still rare: 1-2% of all GI malignancies

Gallbladder Cancer

- cause
  - unknown
  - strong correlation with gallstones
    - 75% of patients with gallbladder cancer

Gallbladder Cancer

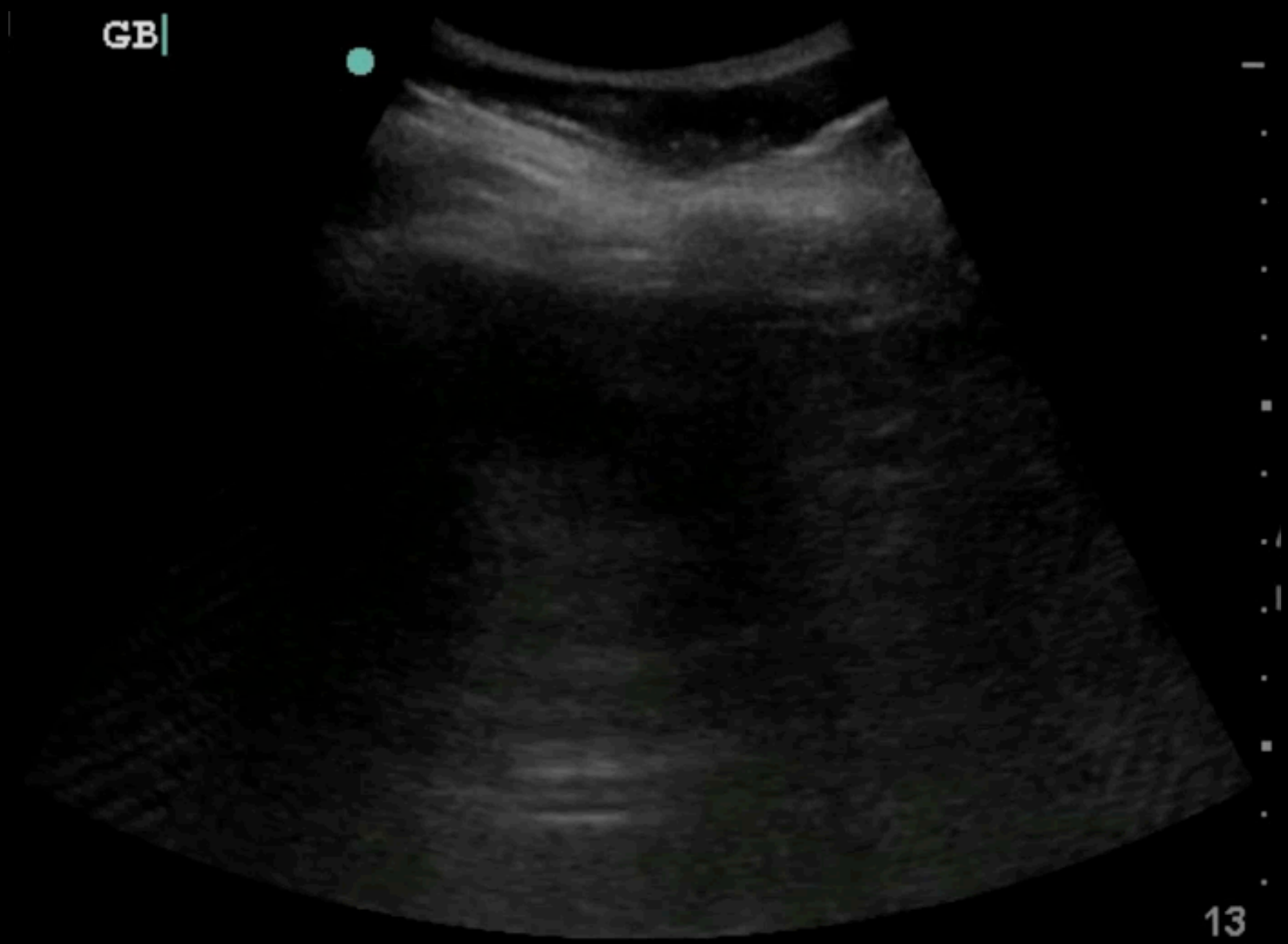
- diagnostic modalities
  - CT
  - MRI
  - ultrasound
    - high rates of false positives and false negatives

Gallbladder Cancer

- gallbladder carcinoma characteristics
  - gallbladder mass
  - polypoid or fungating intraluminal mass
  - diffuse wall thickening
  - direct invasion
- *beyond the scope of the emergency physician*
  - but may be discovered incidentally

Sonographic Pathology

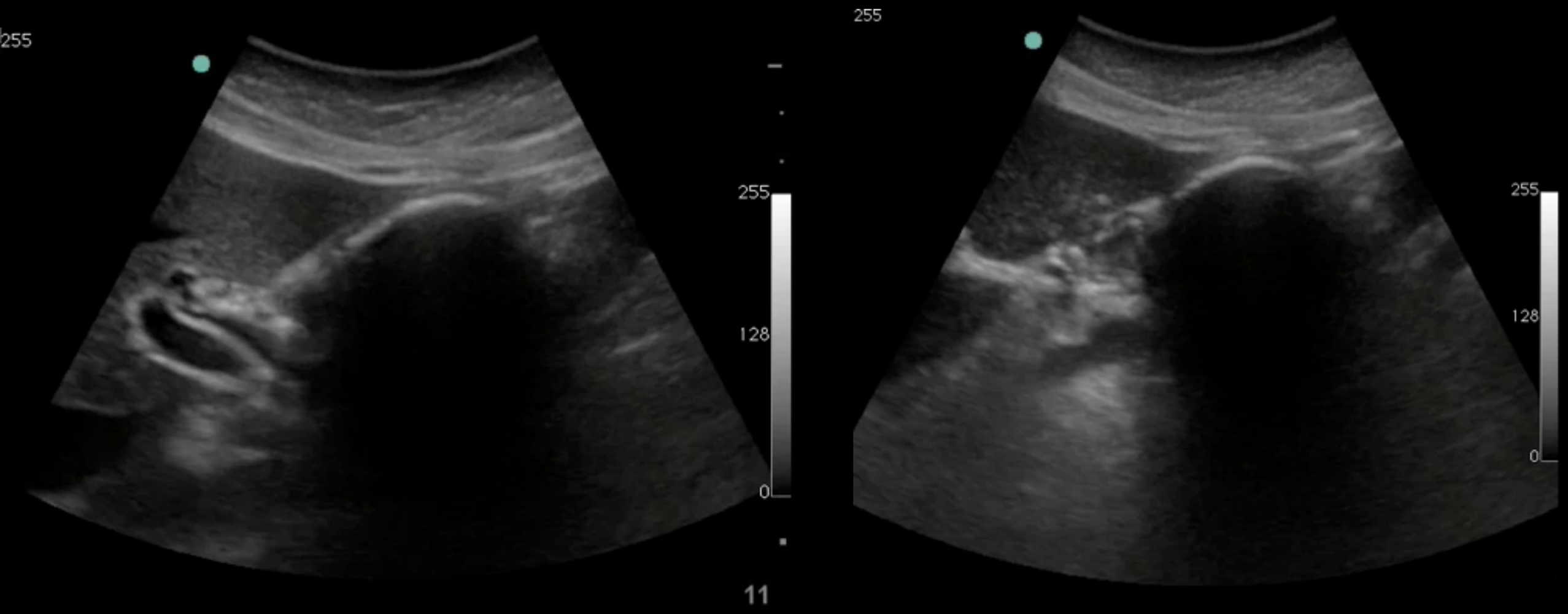
Gallbladder Cancer



gallbladder adenocarcinoma

Sonographic Pathology

Gallbladder Cancer



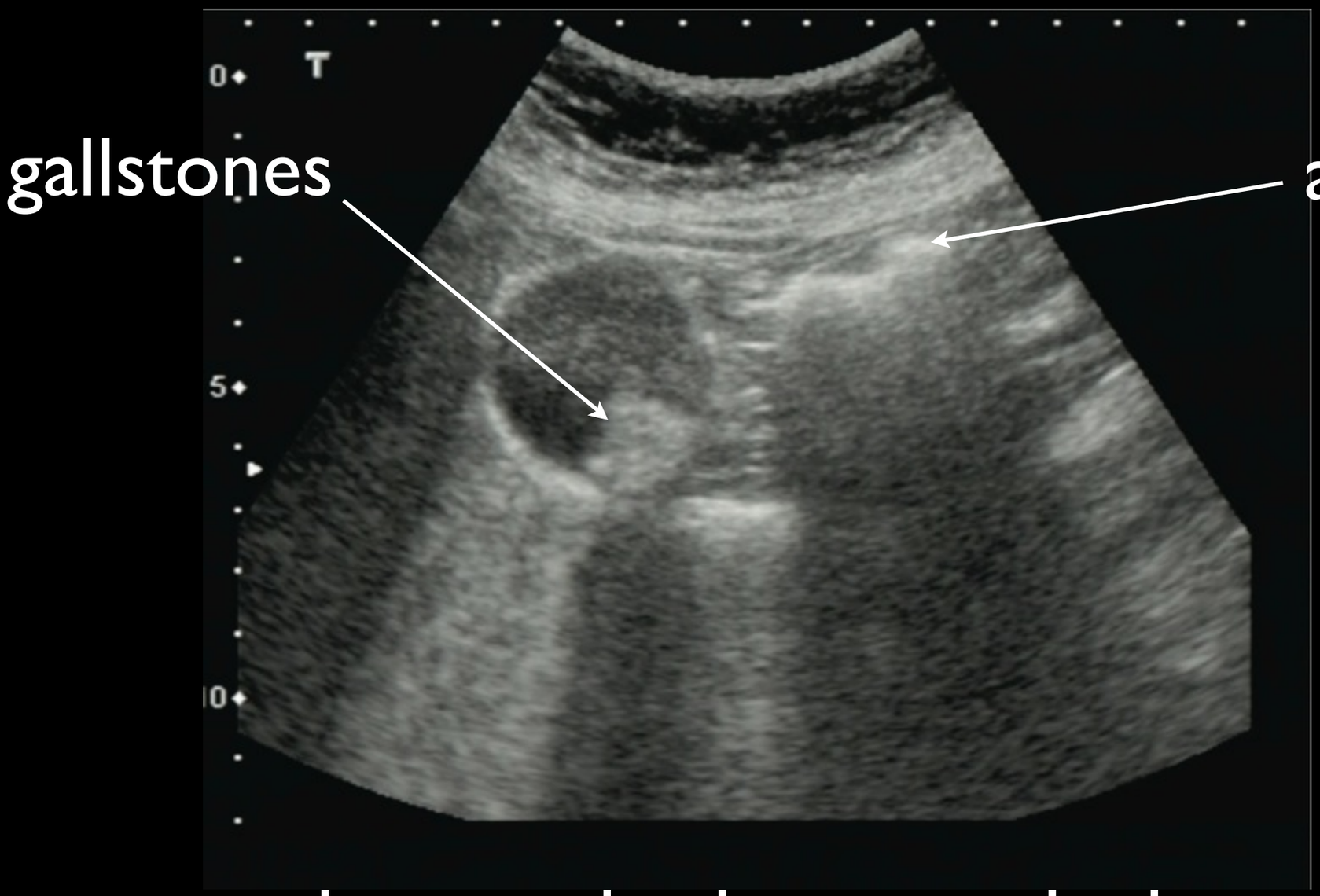
porcelain gallbladder

Pitfalls

Common Errors

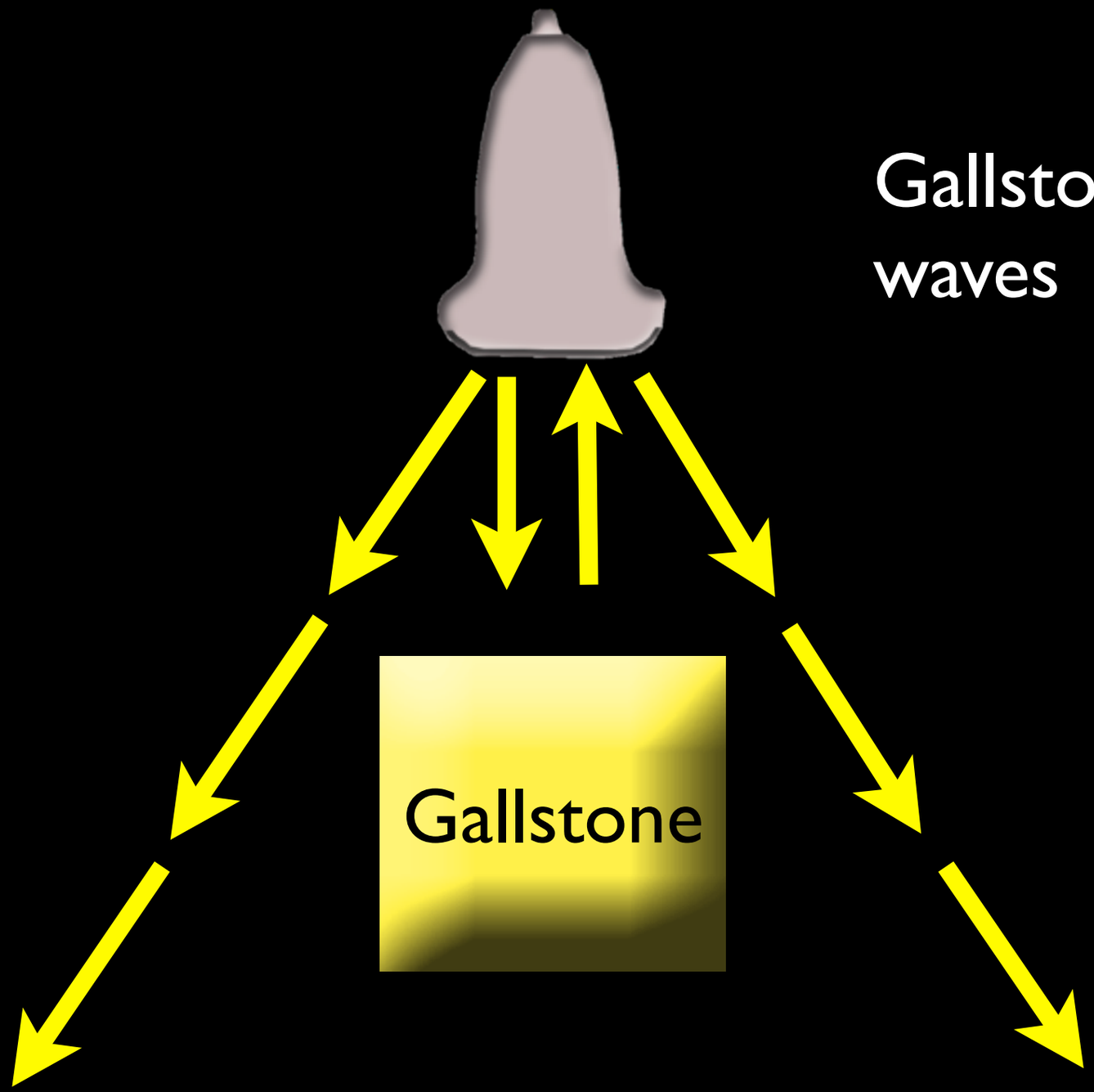
- failing to visualize the entire gallbladder, missing stones
- failing to visualize the gallbladder in 2 axes, missing stones
- overreading artifact and misinterpreting shadows
  - sludge
  - bowel gas
- overreading a poor image quality

Stones vs Bowel Gas



- gas and stones both create shadows, but for different reasons

Stones vs Bowel Gas



Gallstones reflect sound waves

Stones vs Bowel Gas

Air scatters sound

Pitfalls

Stones vs Bowel Gas

- stones should be INSIDE the gallbladder
- check for peristalsis

Gallbladder Polyps

- Polyps are adherent to the gallbladder wall
- Stones should be gravitationally dependent

Pitfalls

Gallbladder Polyps

stones are gravitationally dependent

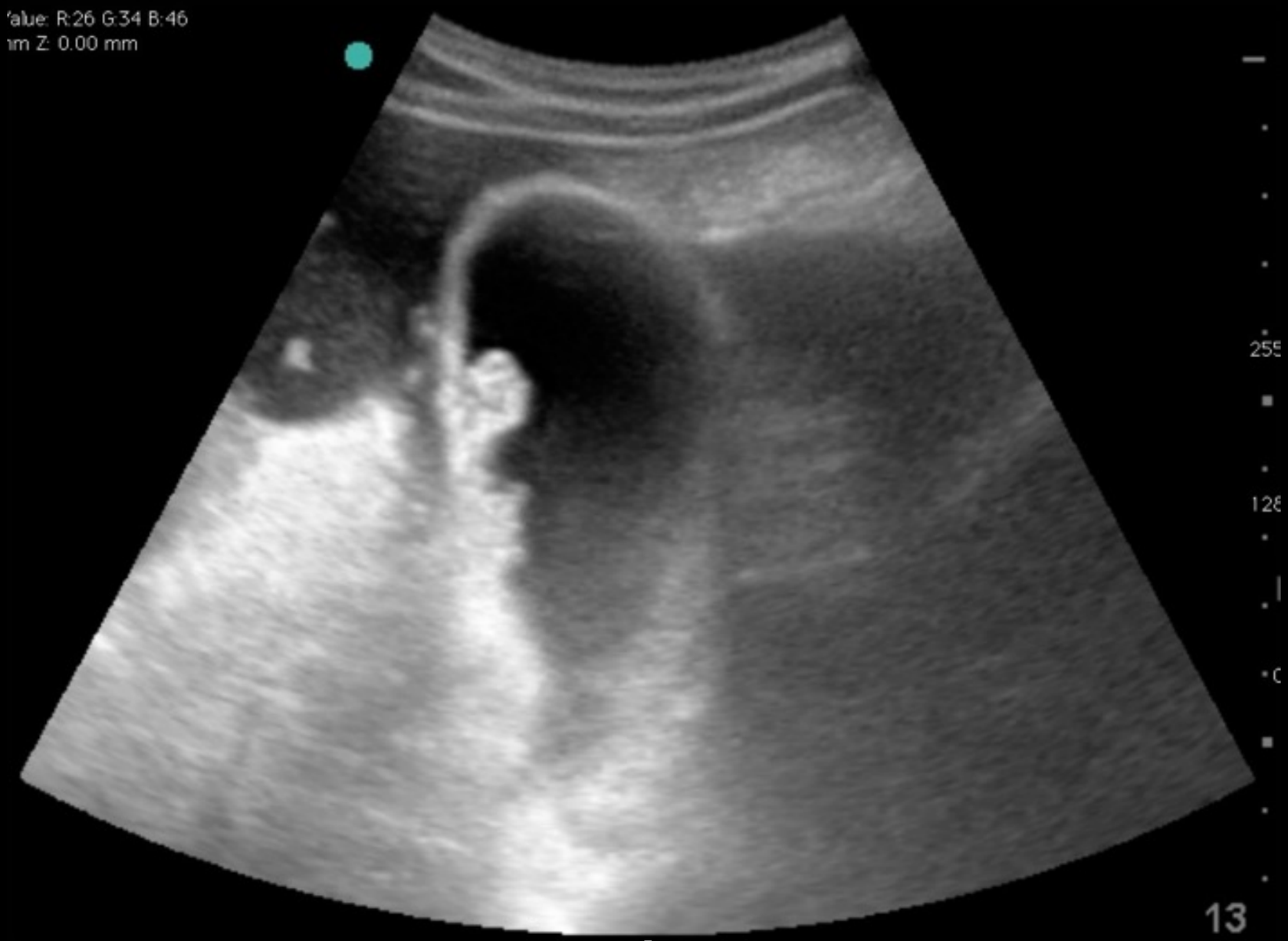
Pitfalls

Gallbladder Polyps

polyp

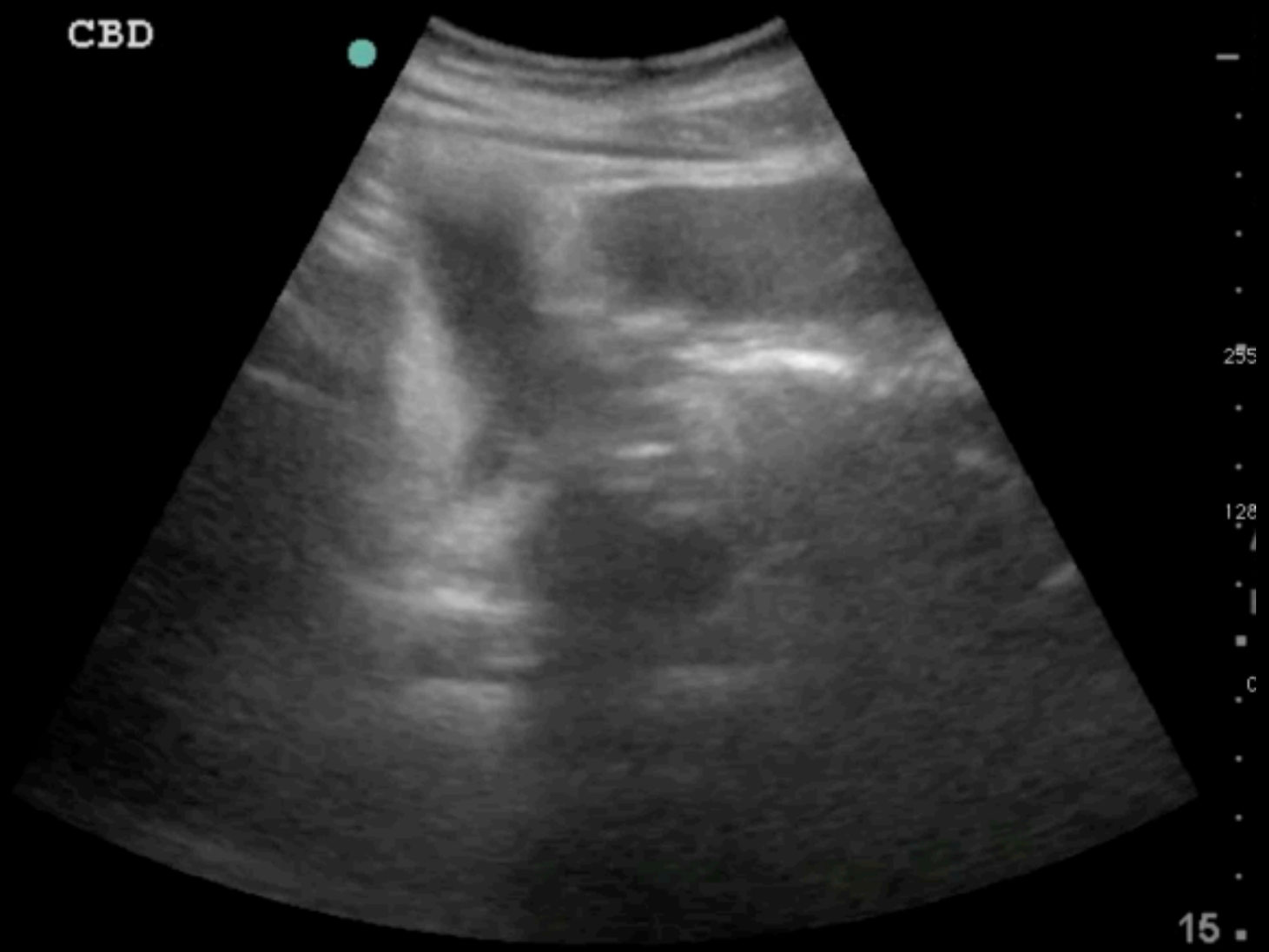
Pitfalls

Gallbladder Polyps



polyp

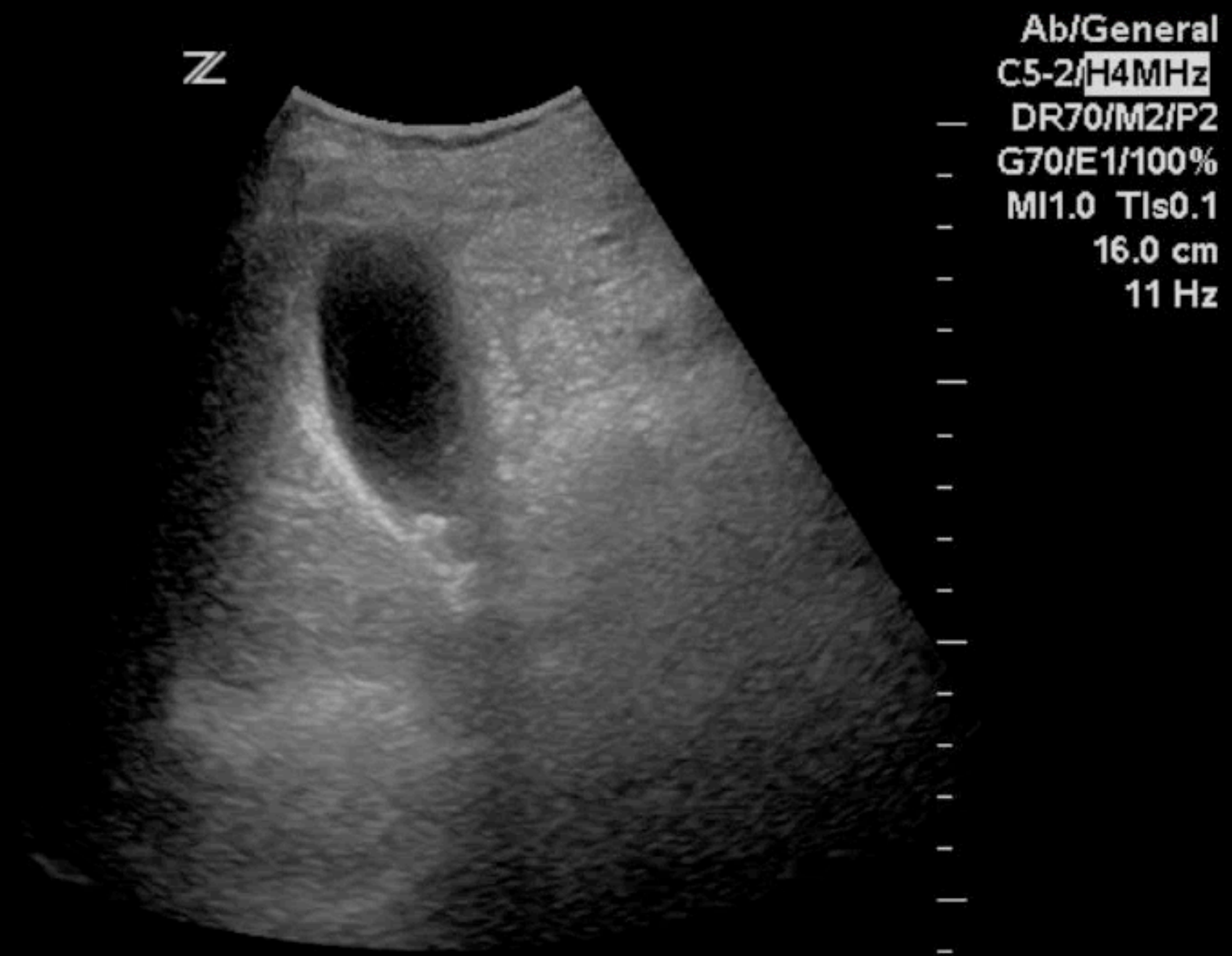
Stone in Neck



- stones in gallbladder neck may be hard to see

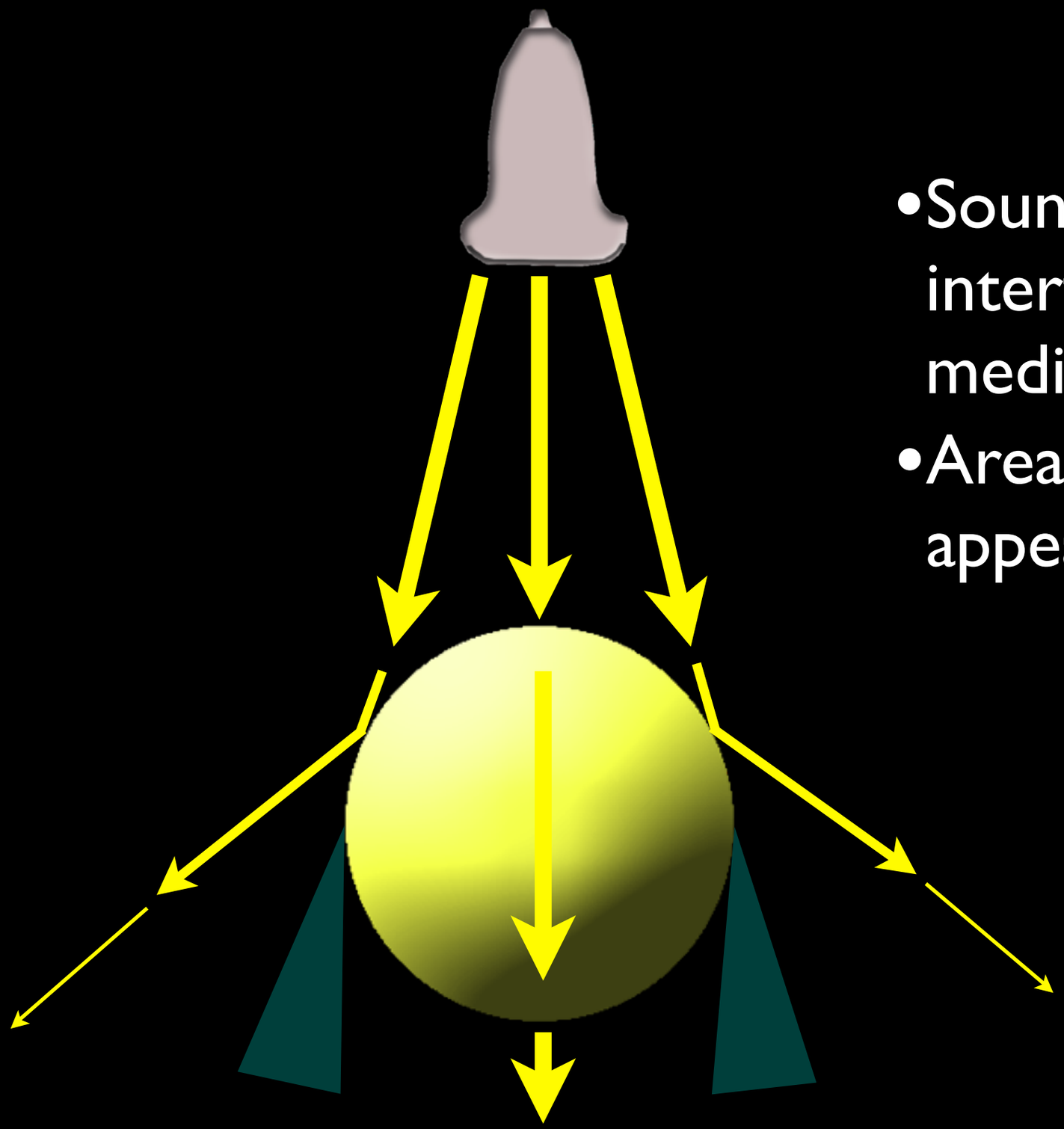
Pitfalls

Stone in Neck



Stone in Neck

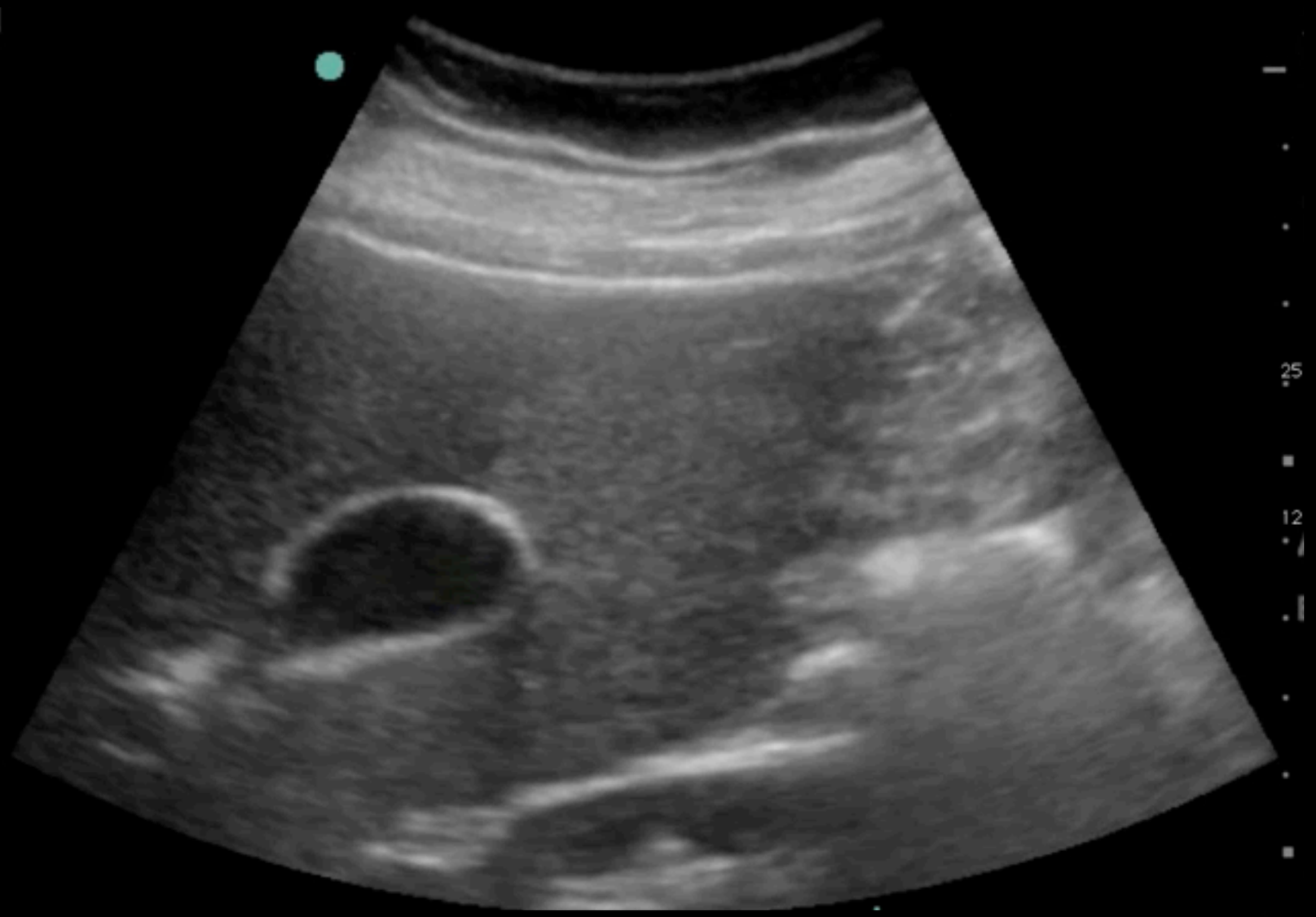
Edge Artifact as Stone



- Sound is bent at the interface between two media (refracted)
- Area behind refraction appears dark

Pitfalls

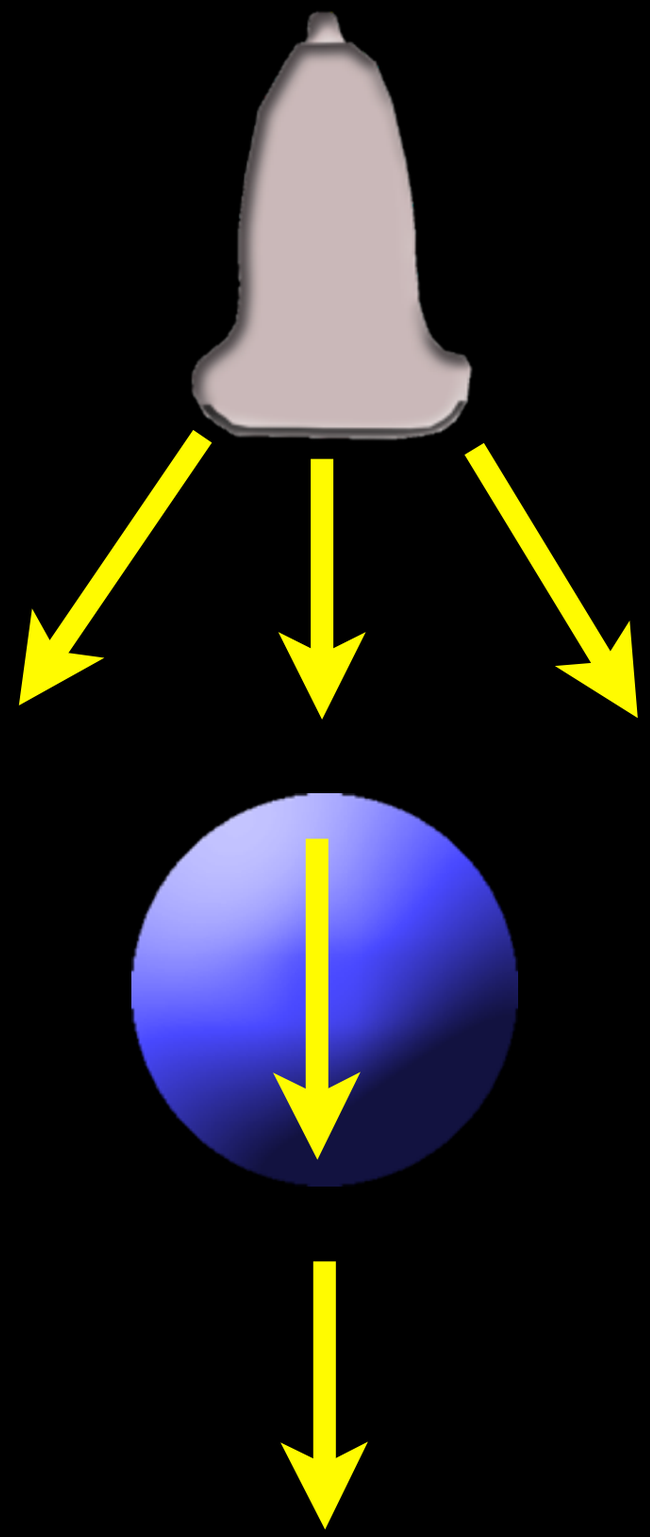
Edge Artifact as Stone



Edge Artifact--not stones

Pitfalls

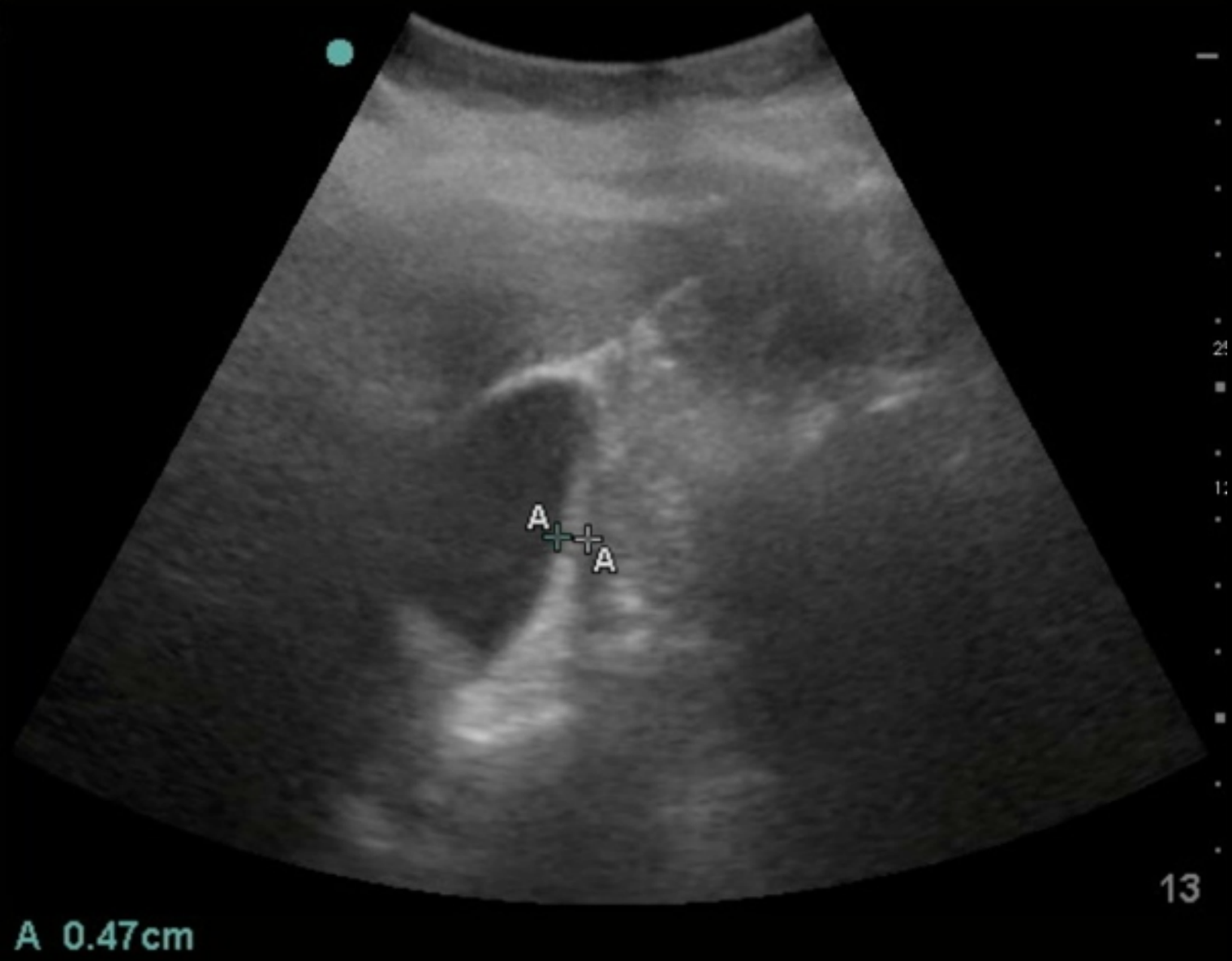
Posterior Acoustic Enhancement



Area posterior to cystic structures is less attenuated and appears brighter

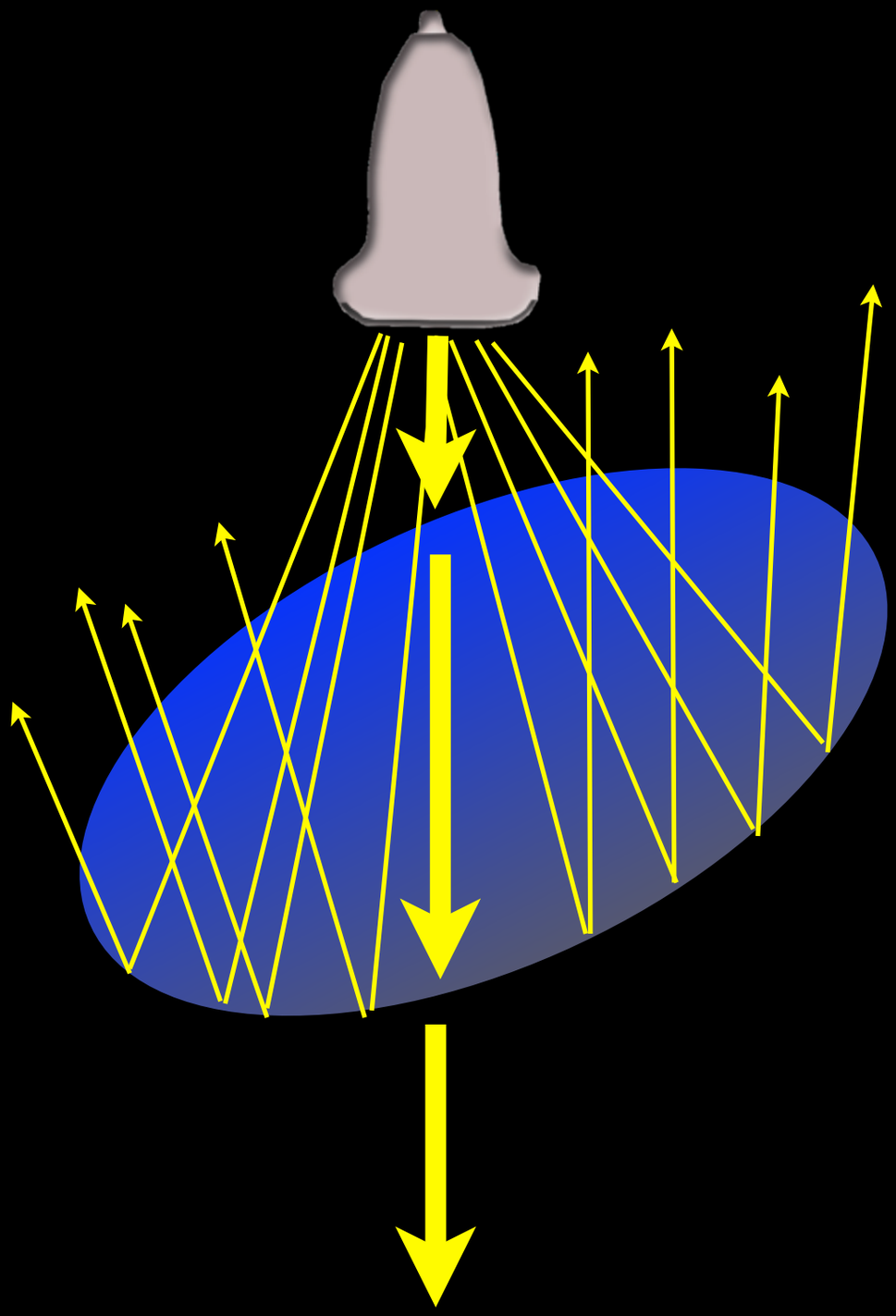
Pitfalls

Posterior Acoustic Enhancement



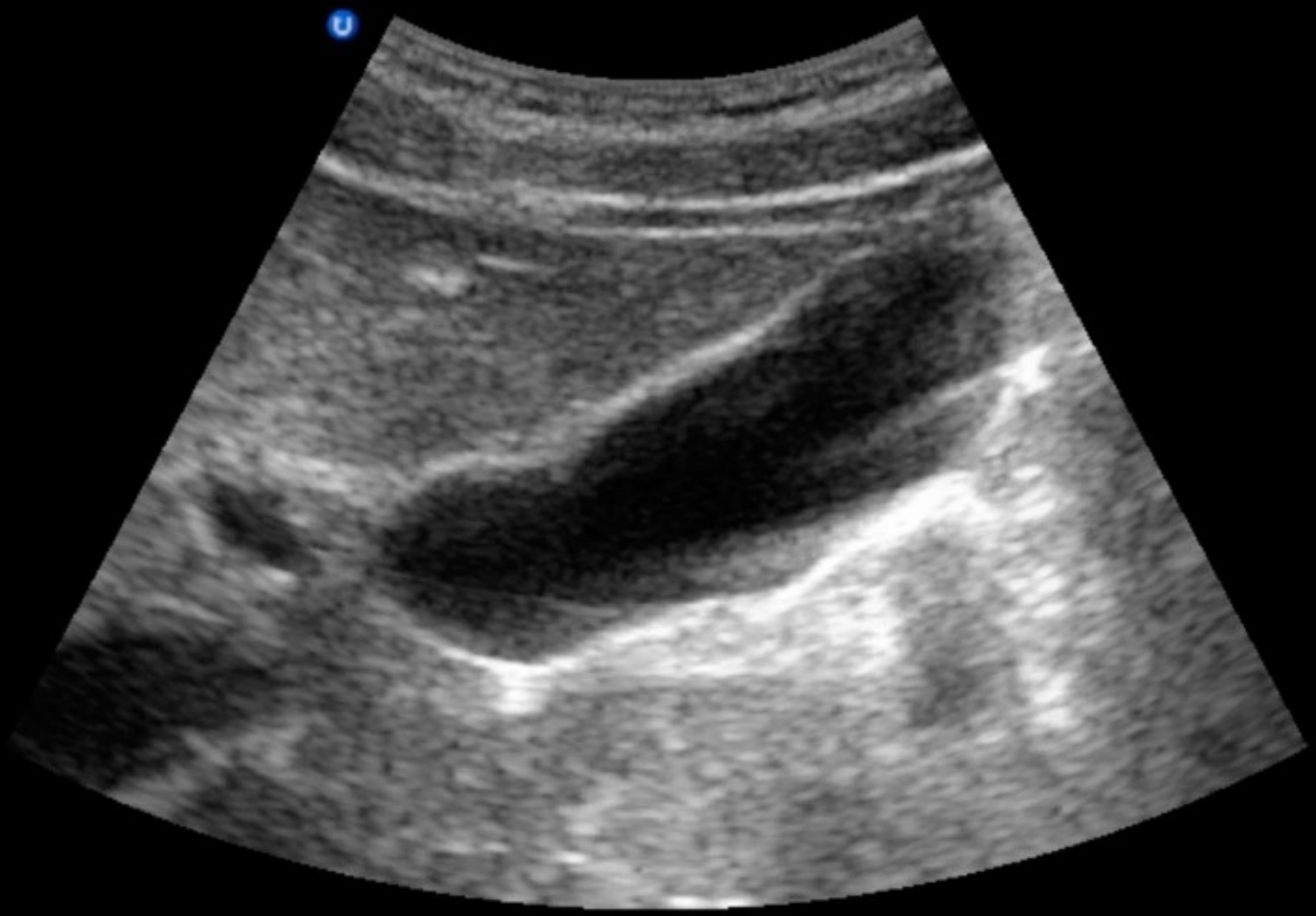
May lead to falsely high measurement: always measure anterior wall

Side Lobe as Sludge



- Sound passes normally through a cystic structure
- Beams at other angles may be reflected off the posterior wall
- May create appearance of "pseudosludge"

Side Lobe as Sludge



edges extend beyond gallbladder wall

Side Lobe as Sludge

- "pseudosludge" --side lobe artifact
  - does not assume a dependent position
  - does not conform precisely to the walls of the gallbladder

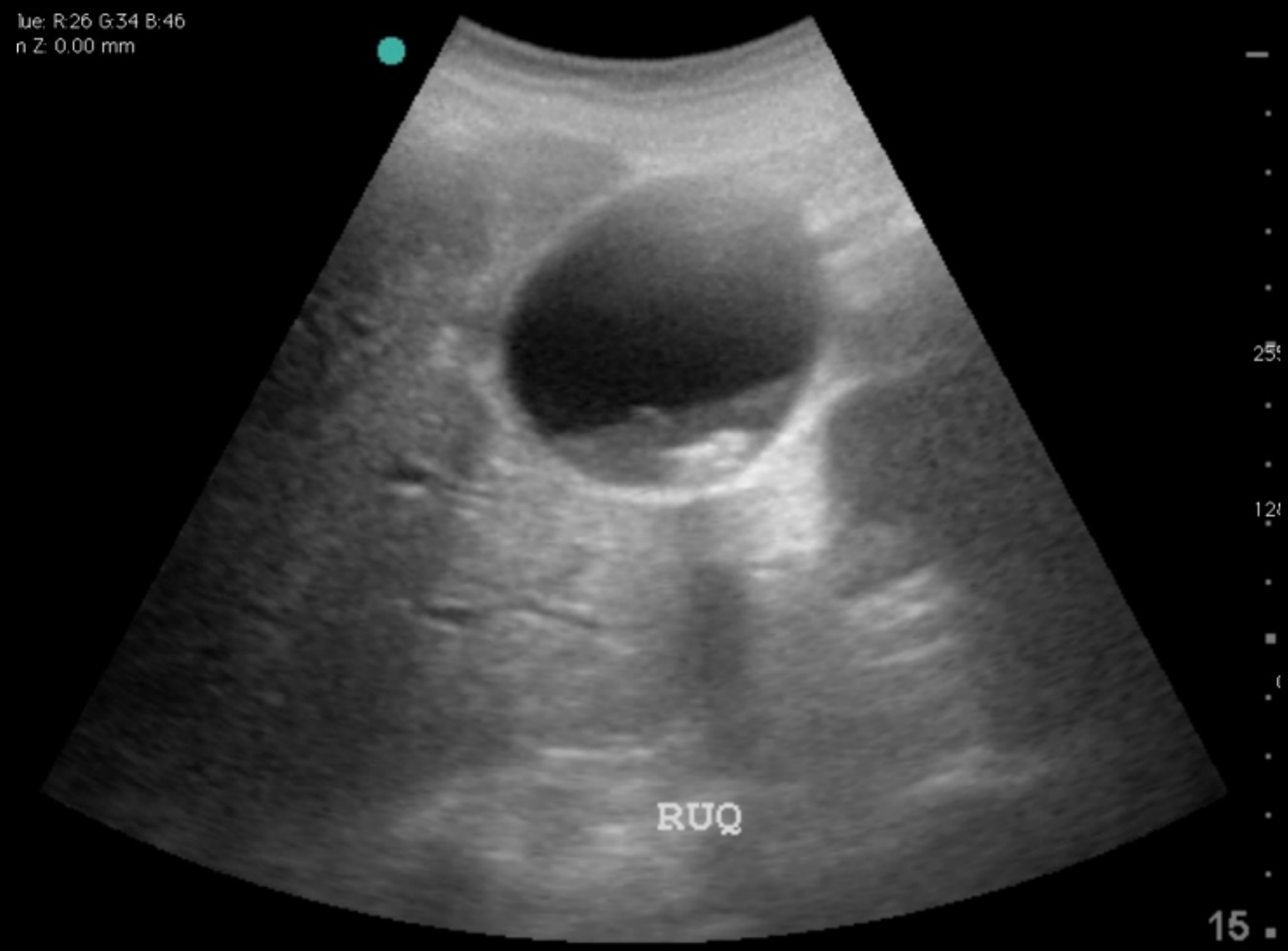
Pitfalls

Side Lobe as Sludge

sludge

Pitfalls

Side Lobe as Sludge



sludge

Cases

Case #1

Abdominal Pain

- 27 y/o female presents at 4:00 AM
- Nausea, vomiting, abdominal pain for 6 hours
- Pain is sharp, intermittent, RUQ
- PMH is unremarkable

Case #1

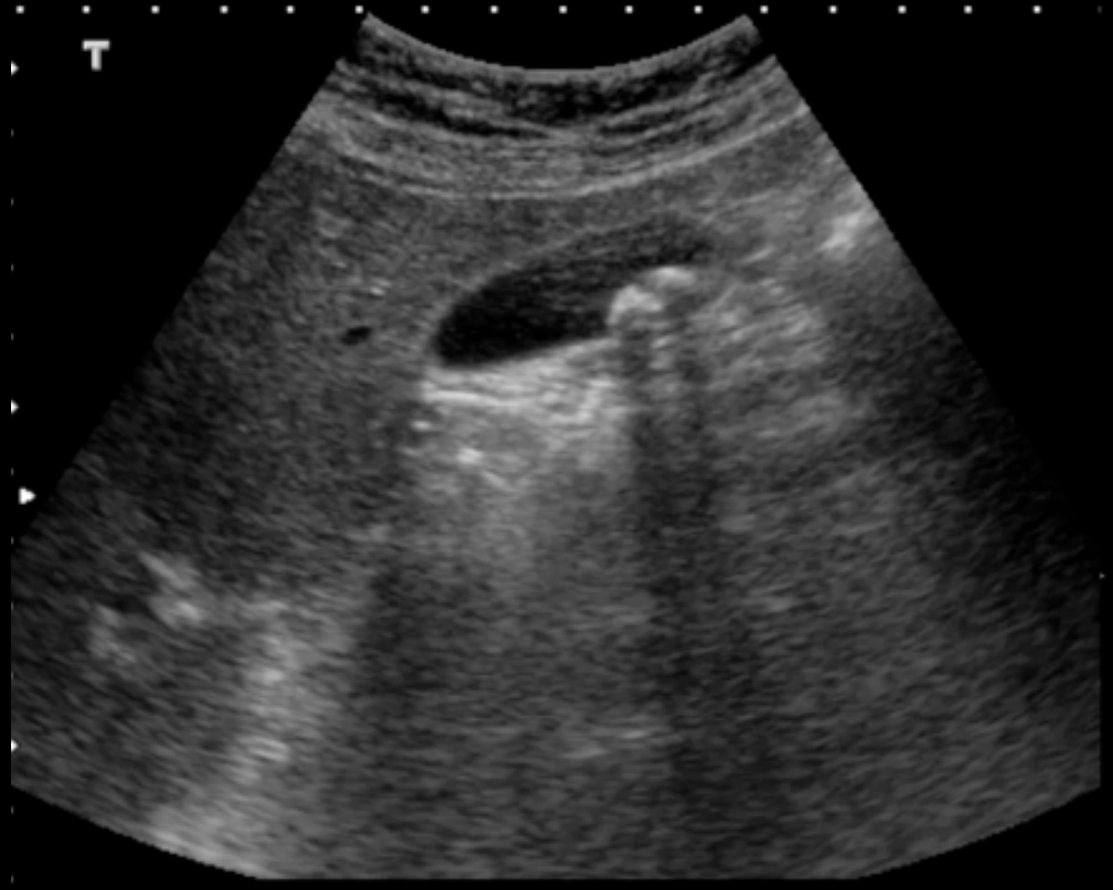
Abdominal Pain

- Vital signs are normal. No fever.
- Appears uncomfortable
- RUQ tender, but no Murphy's sign
- Abdomen otherwise normal
- Pelvic exam normal

Case #1

Abdominal Pain

- shortly after arrival, the gallbladder is located by ultrasound.



Case #1

Abdominal Pain

- multiple gall stones
- gallbladder wall is 3.0mm thick
- CBD diameter is 5mm
- no “sonographic Murphy’s sign”

Case #1

Abdominal Pain

- WBC=9,000
- LFT's, UA, UPT negative
- treated symptomatically
- discharged with surgical referral

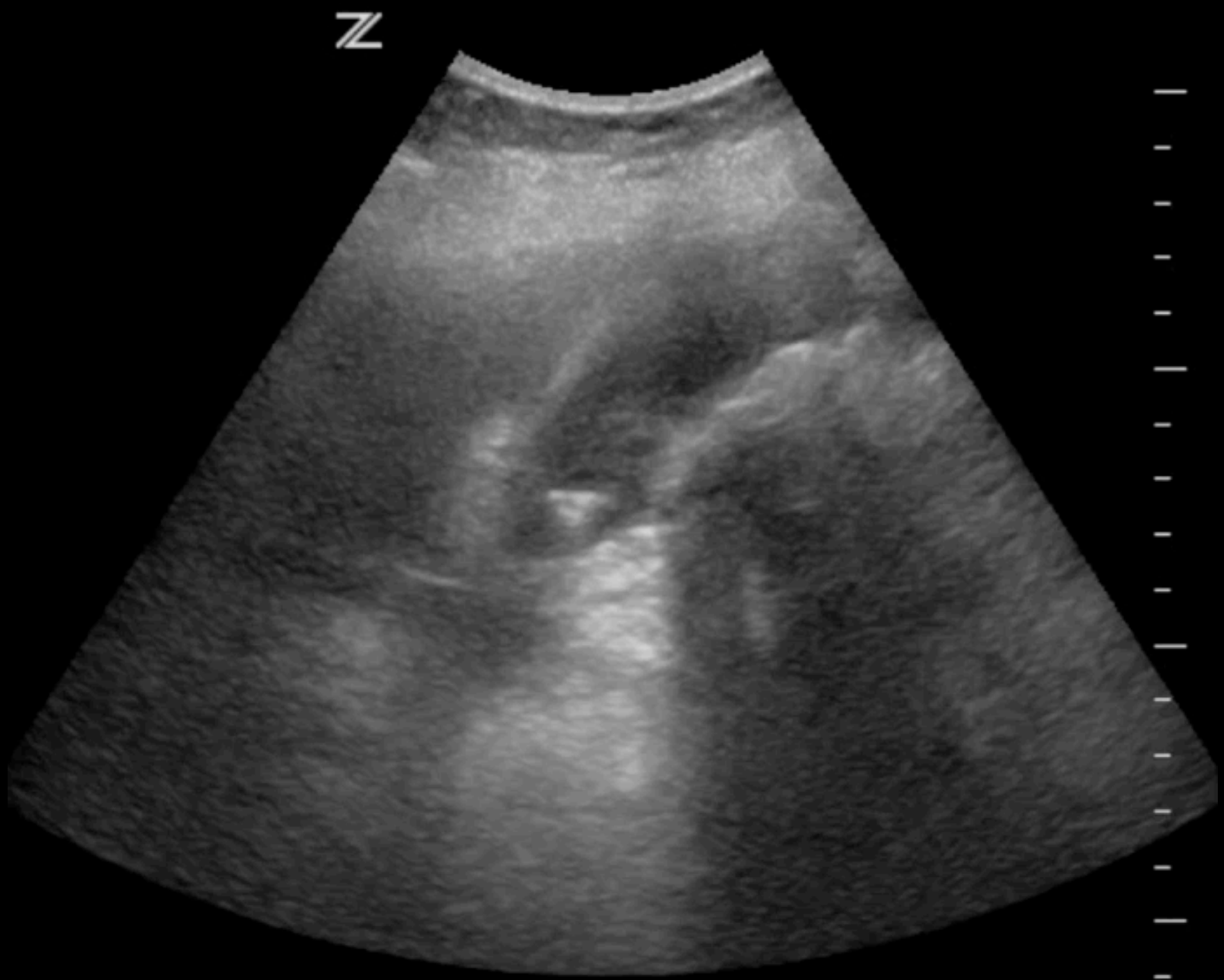
Case #2

Confused, Fever

- 75 y/o AAF sent from NH for AMS, fever
- poorly responsive on arrival, moans occasionally, doesn't follow commands
- T 103 P 120 BP 85/40 SaO2 95% RR 30
- winces with RUQ palpation, exam otherwise unremarkable

Case #2

Confused, Fever



Case #2

Confused, Fever

- Multiple gallstones, wall thickening, pericholecystic fluid
- Antibiotics started, surgery consulted
- WBC 32,000
- Liver function tests elevated
- Total bilirubin 8.2
- CT abdomen demonstrates air throughout the biliary tree

Final Thoughts

- Understand the anatomy
- Patient positioning
- Artifact vs pathology
- Stones can have different appearances, may be hard to find
- Ultrasound findings of cholecystitis
- Know your limitations

Gavin Budhram, MD
Director of Emergency Ultrasound
Baystate Medical Center
Springfield, MA