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OBJECTIVES

- Understand normal **anatomy and physiology** of the pancreas
- Discuss **scanning techniques**, tips, and tricks for sonographic assessment of the pancreas
- Review common **pathology** and sonographic appearance of pathologic findings in the pancreas
- Assess ability to recognize pancreas pathology through **case study review**

3

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THE PANCREAS

The Pancreas is a gland that has both endocrine and exocrine functions with roles in digestion and regulation of blood sugar

Its (mostly) retroperitoneal location and surrounding structures make it a technically challenging organ to scan

4

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PHYSIOLOGY

Endocrine function (Hormonal) Islets of Langerhans

- **Alpha Cells** - secrete glucagon (Glycogen to Glucose)
- **Beta Cells** - secrete insulin (Glucose to Glycogen)
- **Delta Cells** - secrete somatostatin (Alpha and Beta inhibitor)
- **Epsilon Cells** - secrete Ghrelin (modulate Alpha and Beta cells)
- **F Cells** - secrete Pancreatic Polypeptide (inhibits exocrine secretion)

5

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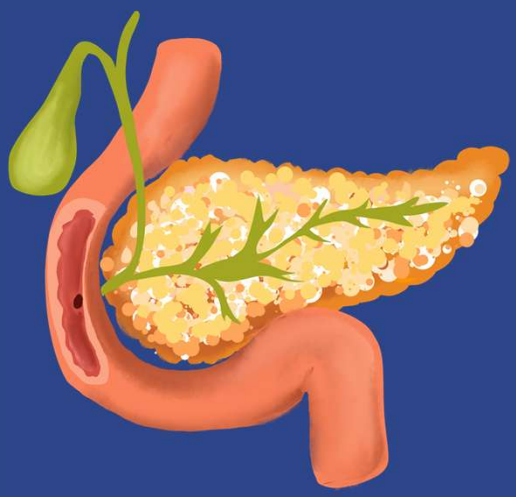
PHYSIOLOGY

Exocrine function (Digestive) Acini cells

- **Lipase** - digests fats
- **Amylase** - digests carbohydrates
- **Trypsin** - digest proteins
- **Chymotrypsinogen** - digest proteins
- **Carboxypeptidase** - digest proteins
- **Nucleases** - digest nucleic acids



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LAB VALUES

↑ AMYLASE	acute pancreatitis, mumps, ischemic bowel disease, pelvic inflammatory disease
↑ LIPASE	acute pancreatitis, pancreatic carcinoma
↑ GLUCOSE	severe diabetes, chronic liver disease, overactive endocrine glands
↓ GLUCOSE	islet of Langerhans tumor

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ANATOMY

- Divided into....

8

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SONOGRAPHICALLY

Size
- Head <3 cm
- Neck/Body <2.5 cm
- Tail <2.0 cm

Echogenicity
- >liver, </> spleen

Echotexture
- Homogeneous

Surface
- Smooth to slightly lobular

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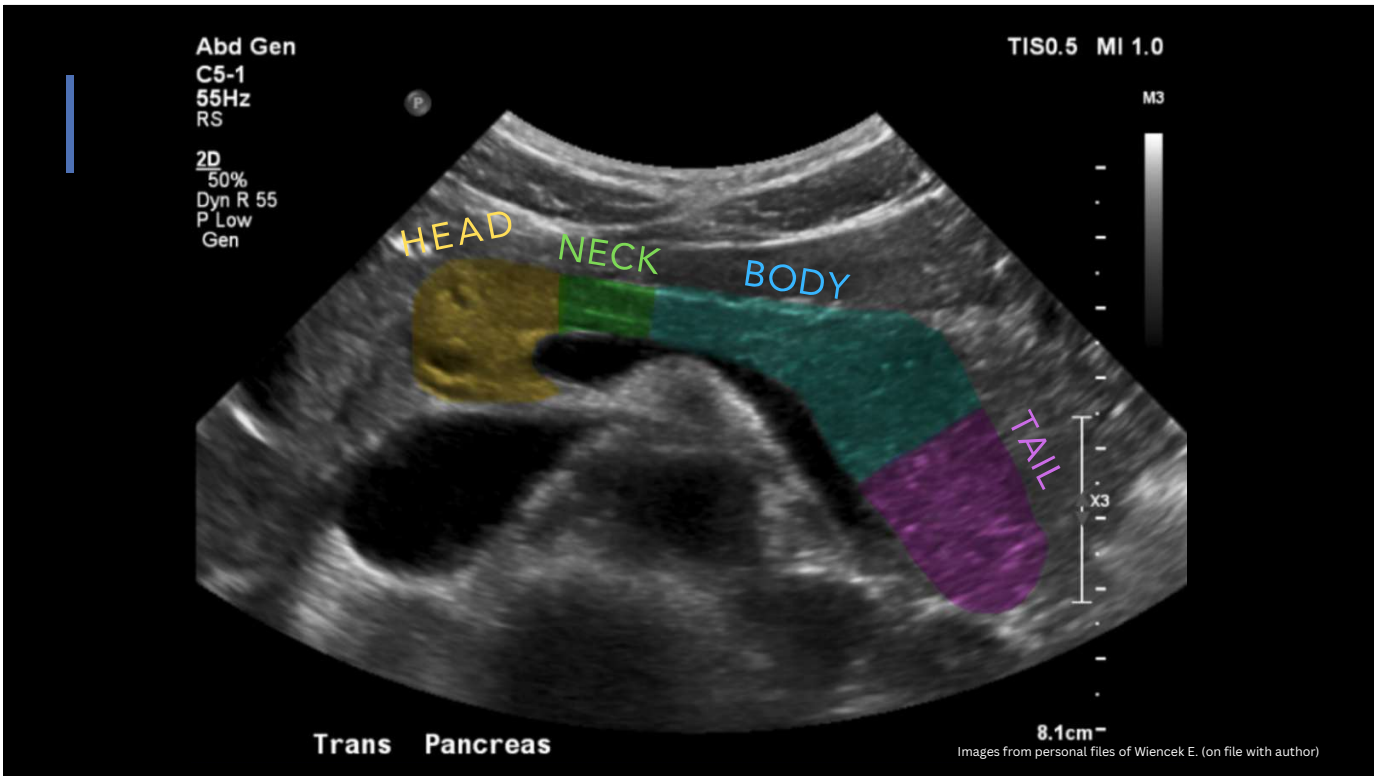

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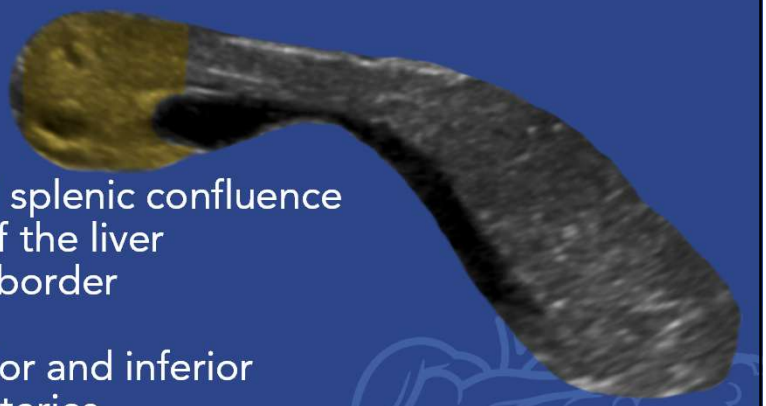
THE HEAD



- Most inferior portion
- Anterior to IVC
- To the right of the portal splenic confluence
- Inferior to the left lobe of the liver
- GDA and CBD at lateral border

- Blood supply from anterior and inferior pancreaticoduodenal arteries

Uncinate process
- Small curved portion at the end of the head
- Posterior to the SMV

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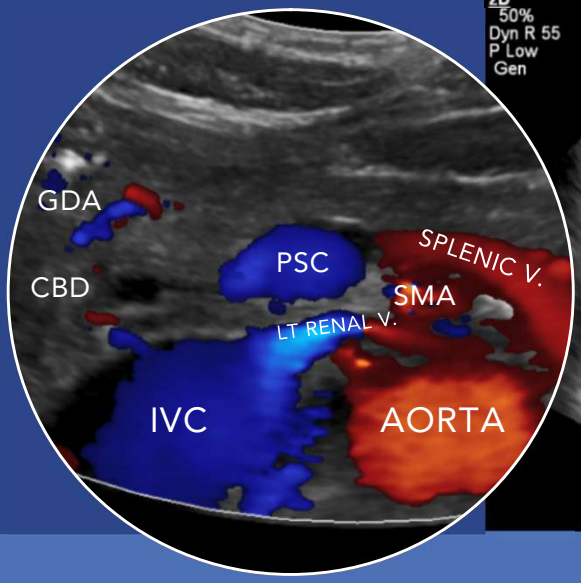
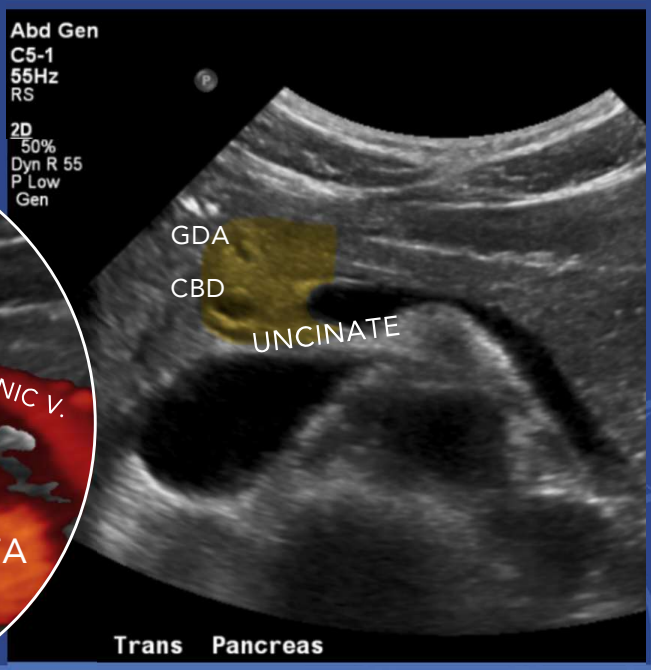
THE HEAD





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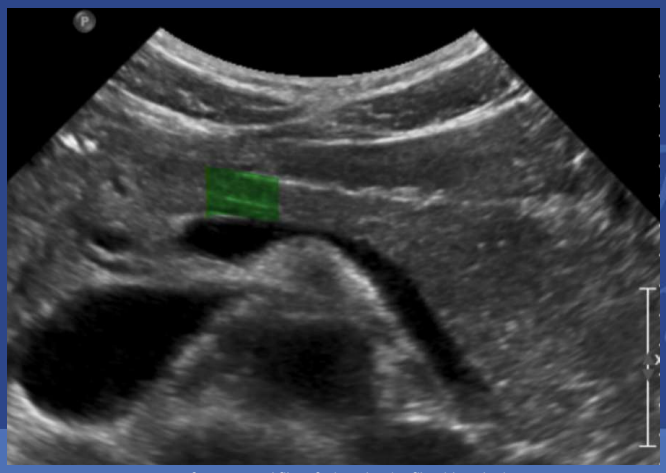
THE NECK

- Anterior to the portal splenic confluence/ SMV
- Often included as part of the body



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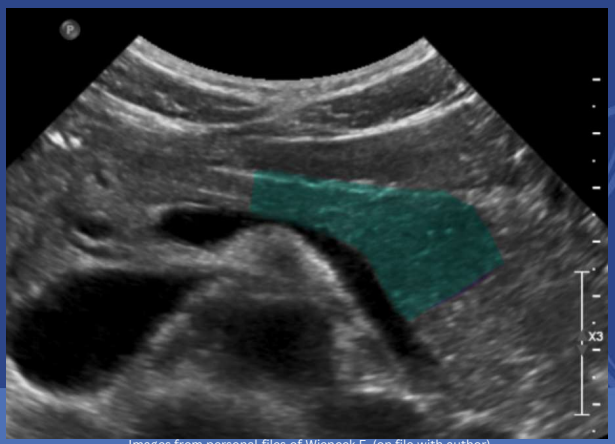
THE BODY

- Largest portion of the gland
- Anterior to aorta, SMA, and left renal vein
- Anterior to splenic vein (forms posterior border)



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THE TAIL

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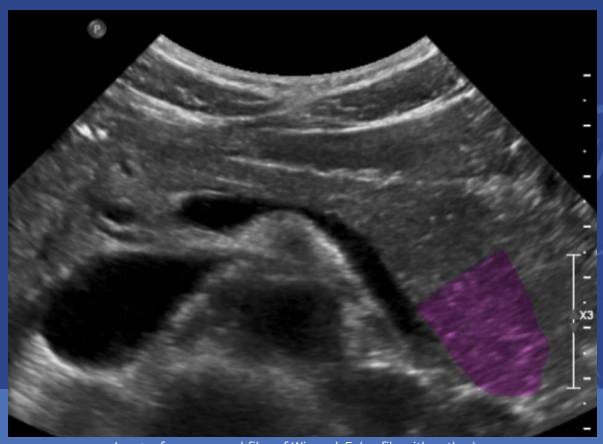
- Continuous with body and terminates at splenic hilum
- Splenic vein forms posterior border
- Branches of the Splenic artery feed the body and tail
- Venous drainage through tributaries of splenic v. and SMV



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THE TAIL

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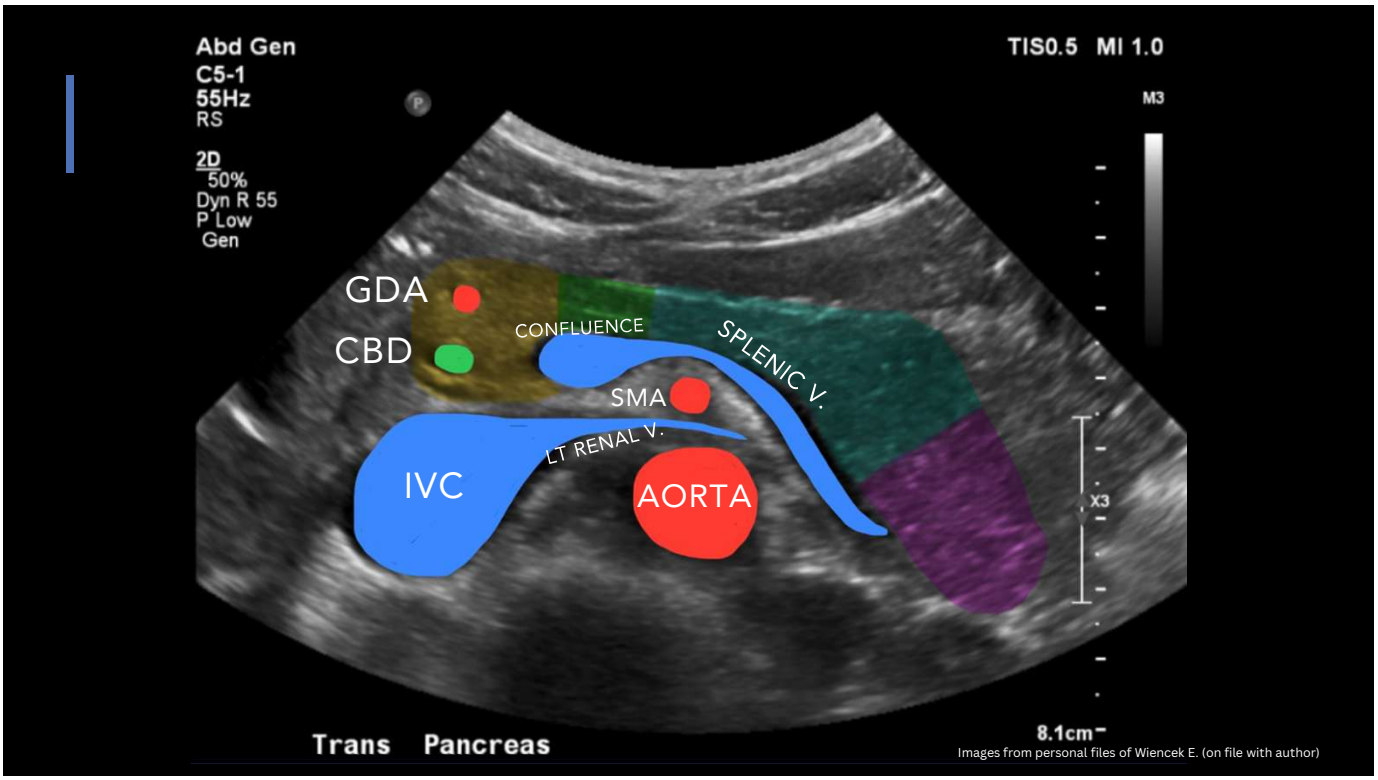

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RELATIONAL ANATOMY

What else can we see?

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NUTCRACKER ANATOMY

'Nutcracker Anatomy' or 'Nutcracker Phenomenon'

- Compression of left renal vein as it passes between the Aorta and SMA
- Common incidental on CT
- Common in thin patients
- Nutcracker SYNDROME when it is symptomatic

Clinical signs:

- Hematuria, flank pain, varicoceles

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DUCTAL ANATOMY

- **Duct of Wirsung (Pancreatic Duct)** - drains entire length of gland
- **Duct of Santorini (Accessory Duct)** - drains anterior head of gland

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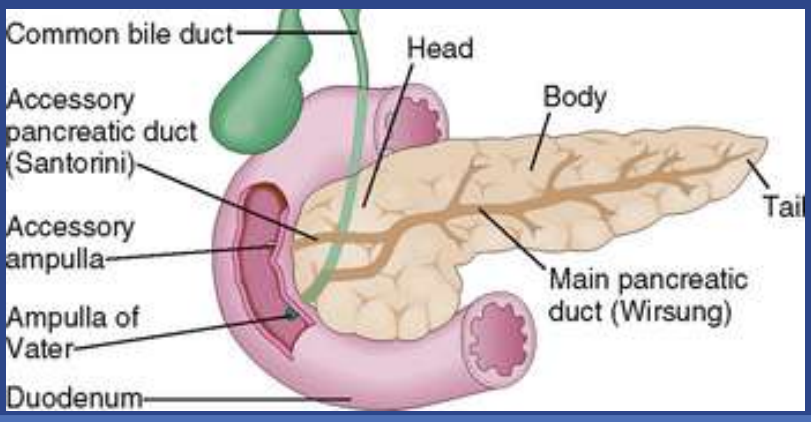

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DUCTAL ANATOMY

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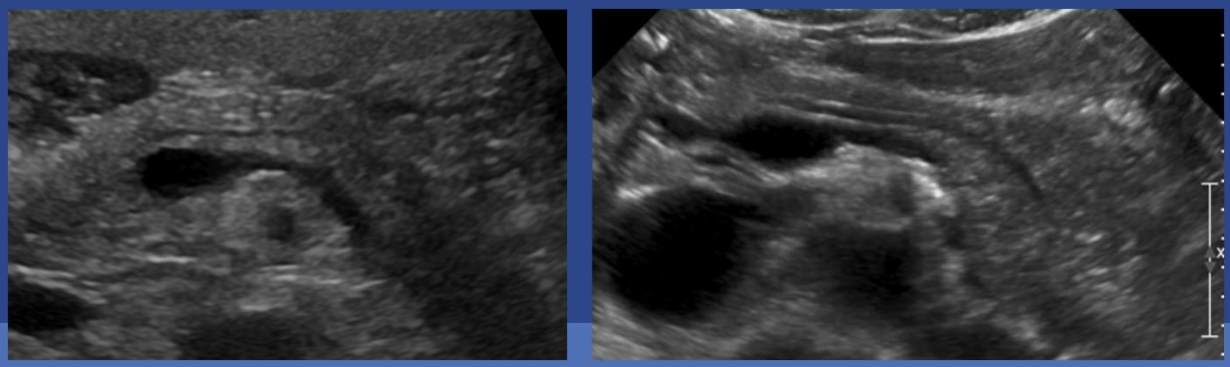
- Usually not visualized unless pathologic or in thin patient
- Abnormal when…
  - >3mm at head
  - >2mm at Body/Tail



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SCANNING TECHNIQUE

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One of the most difficult organs to scan due to surrounding GI structures (stomach and transverse colon)

- Patient should be NPO 6-8 hours
- 2.5-5 MHz curvilinear transducer
- Supine or LLD

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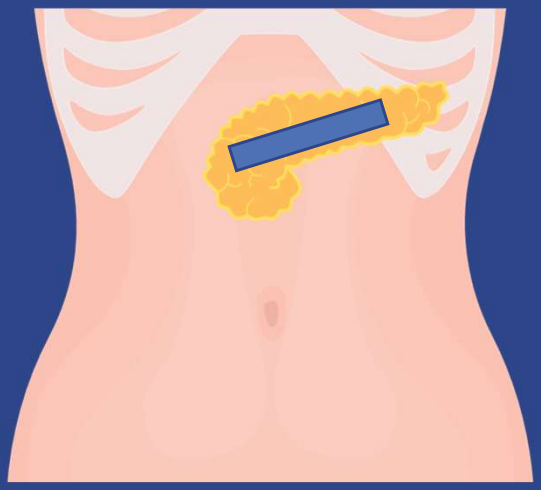
SCANNING TECHNIQUE



In Transverse:
Orient Transducer with right side angled superior toward patients left shoulder

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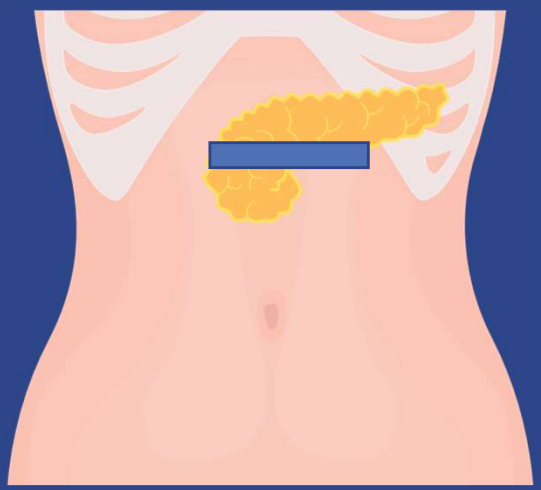
SCANNING TECHNIQUE



In Transverse:
Align the transducer transverse on the organ, not necessarily transverse on the patient

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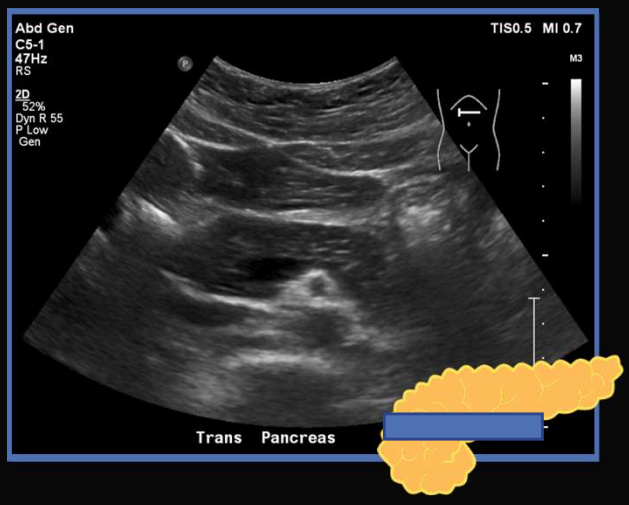
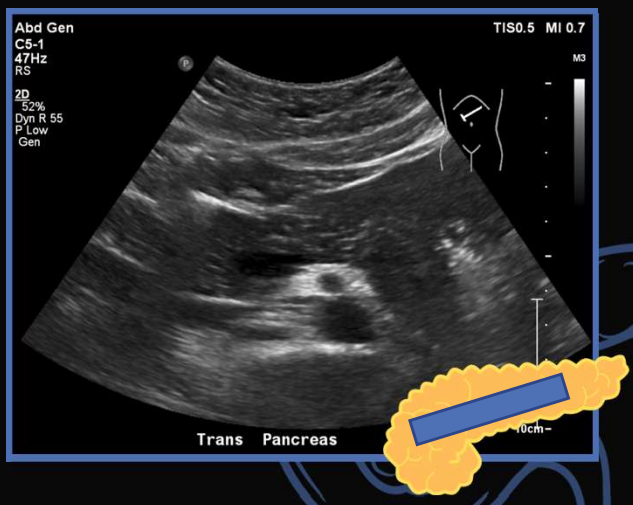
ELONGATES THE TAIL BETTER





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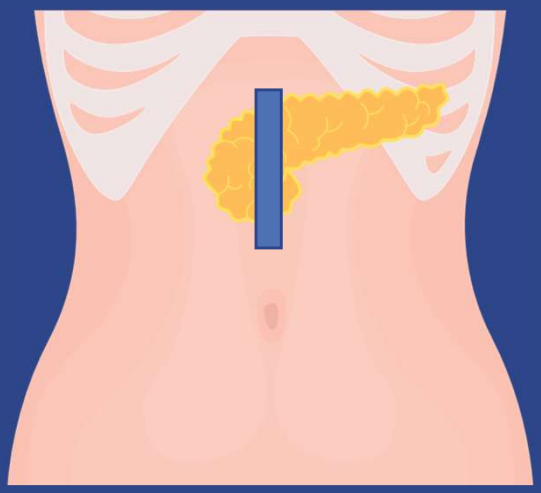
SCANNING TECHNIQUE



In Sagittal:
Not all facilities routinely scan this plane

Tip:
- Find the Aorta first
- Can help locate pancreas in difficult cases

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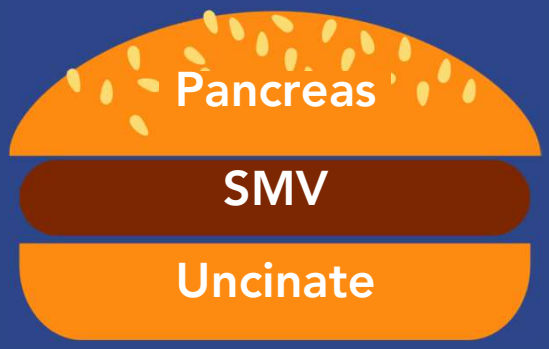
SAGITTAL PANCREAS



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SAGITTAL PANCREAS

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SCANNING TECHNIQUE

Helpful Tips:

- Have patient "push out their stomach"
- Have patient drink a glass of water and use stomach as a window
- RLD and intercostal using the spleen as an acoustic window for thin patients

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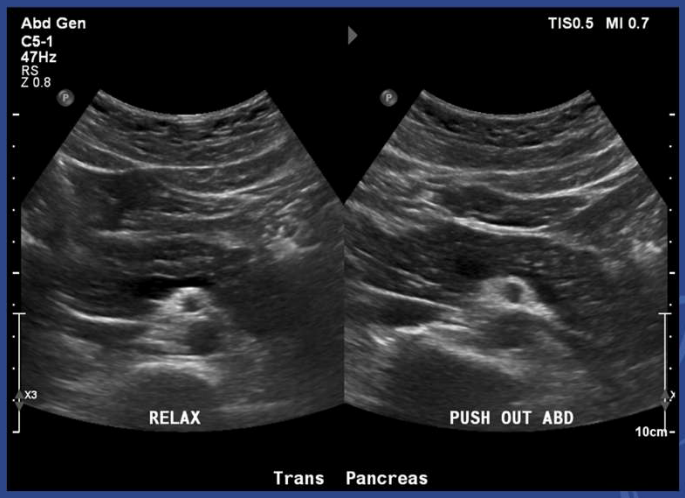
PUSH OUT STOMACH



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"push out your stomach like you're making a pot belly"
"take a big breath in and blow all of the air out"
"bear down and puff out your stomach"

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WATER TECHNIQUE

You can sit the patient up slightly to bring the stomach more over the area of interest

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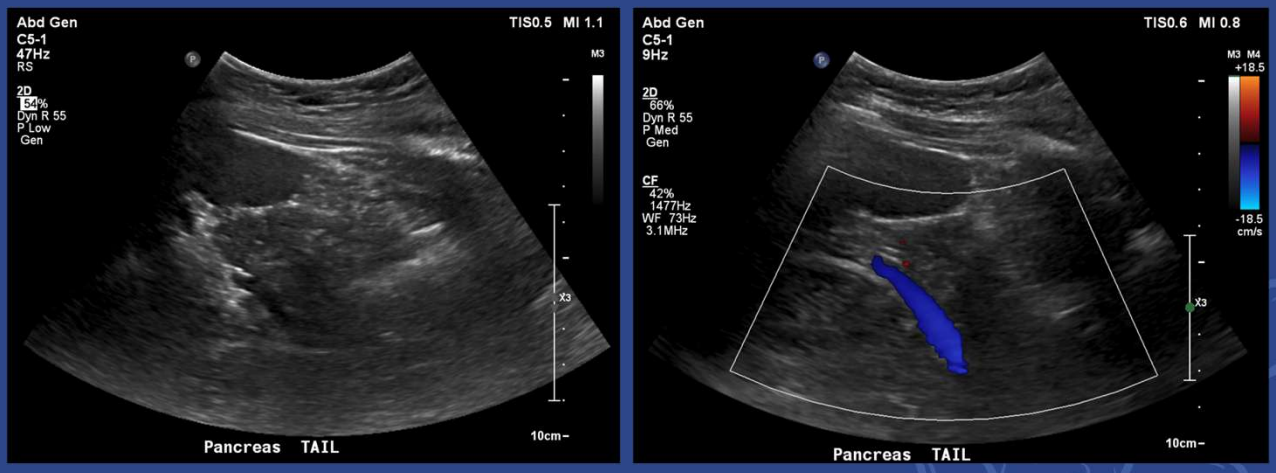
RLD TECHNIQUE



Visualize the tail by using the spleen as an acoustic window

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PATHOLOGY

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SYMPTOMOLGY

- Pain arising from the pancreas is poorly localized. Patients may present with lower thoracic and low back pain

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PANCREATITIS

- Inflammation of the pancreas from increased secretion and/or blocked ducts
- Pancreatic tissue may be digested by its own enzymes
- May be chronic or acute
- CT with contrast gold standard for acute form

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RISK FACTORS

- Alcohol abuse
- Gallstones
- Metabolic disorders
- Trauma
- Malignancy
- Infection
- Toxins (spider bites, scorpion stings)
- Idiopathic (20%)

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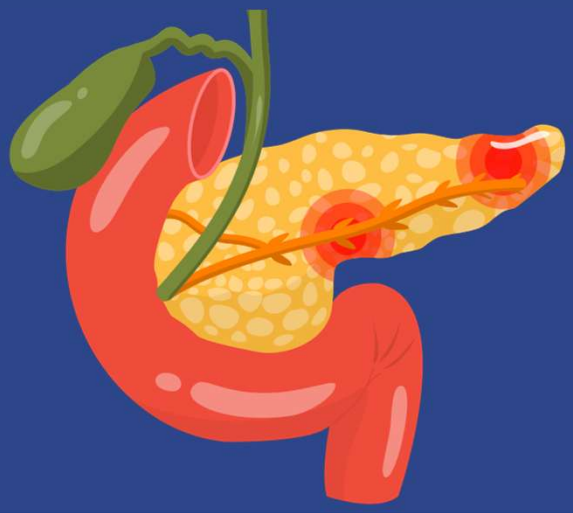
ACUTE PANCREATITIS

Symptoms -
- Epigastric pain (can radiate to back)
- Nausea and vomiting
- Postprandial pain

Causes -
- Biliary disease/obstruction
- Alcohol abuse

Labs -
- Elevated amylase and lipase



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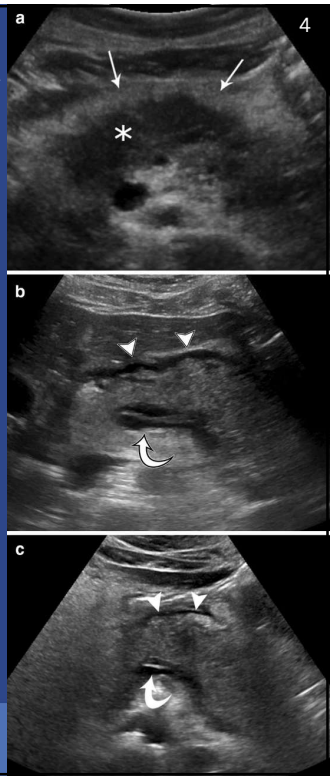
ACUTE PANCREATITIS[1]

Sonographic Findings -
- Focal or diffuse
- Mild, moderate or severe
- Enlarged gland
- Hypoechoic
- Inhomogeneous echotexture
- Dilation of pancreatic duct
- Free fluid (perivascular cloaking)
- May have assoc. stones or thrombus



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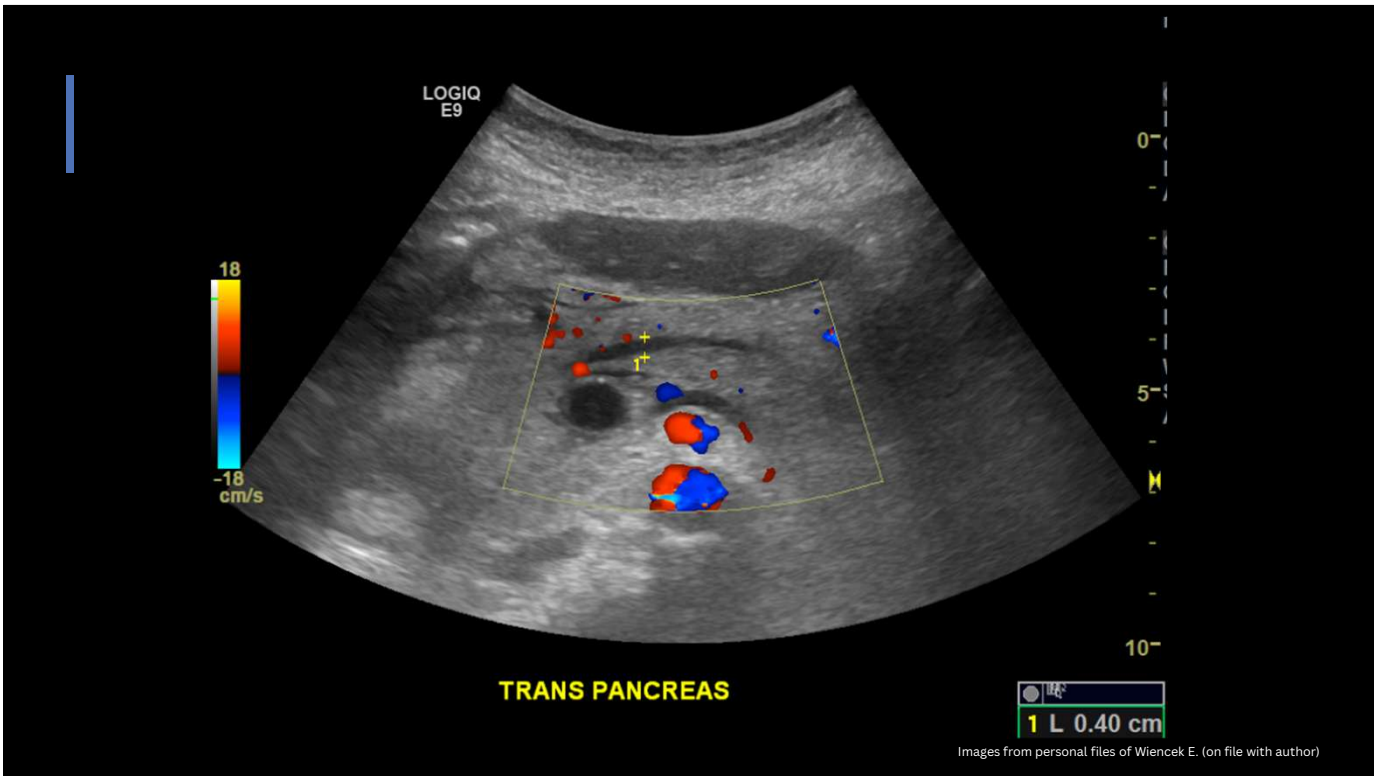

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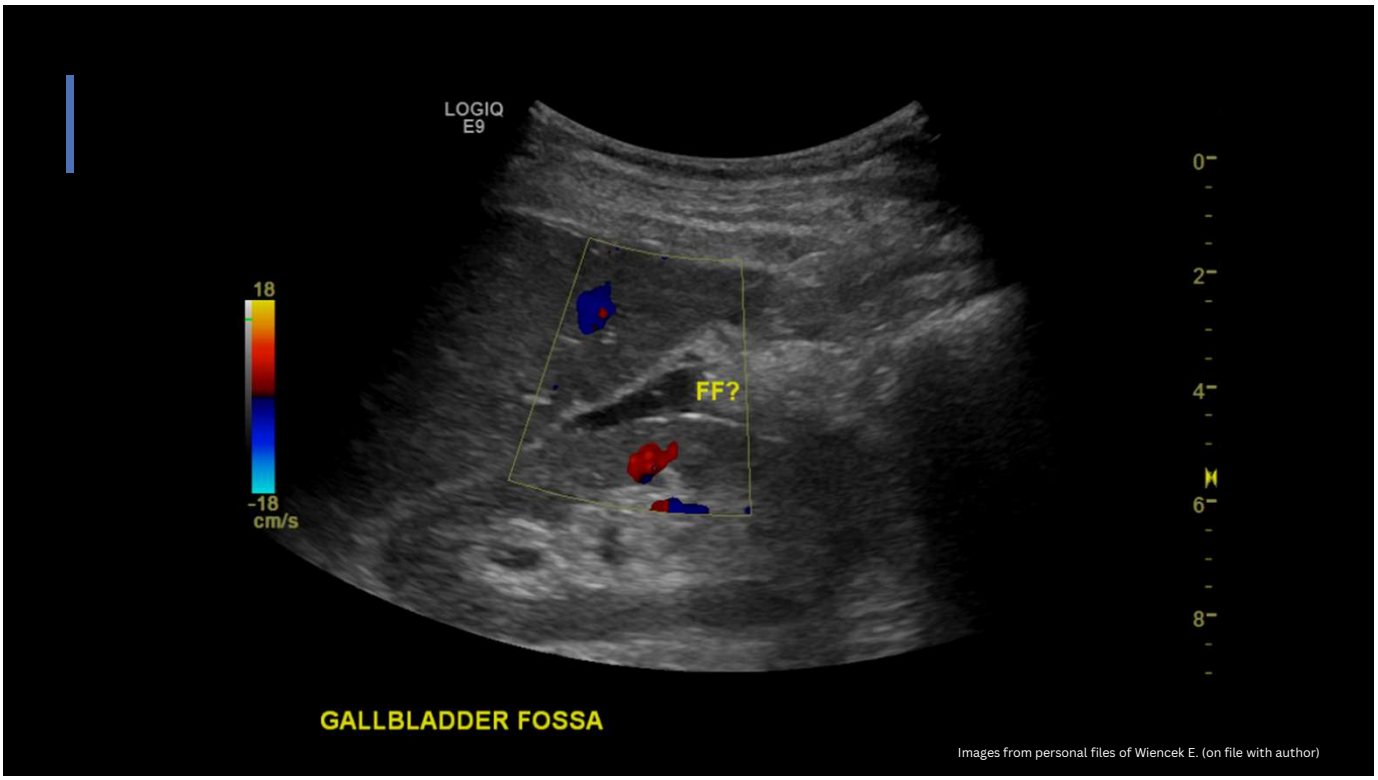

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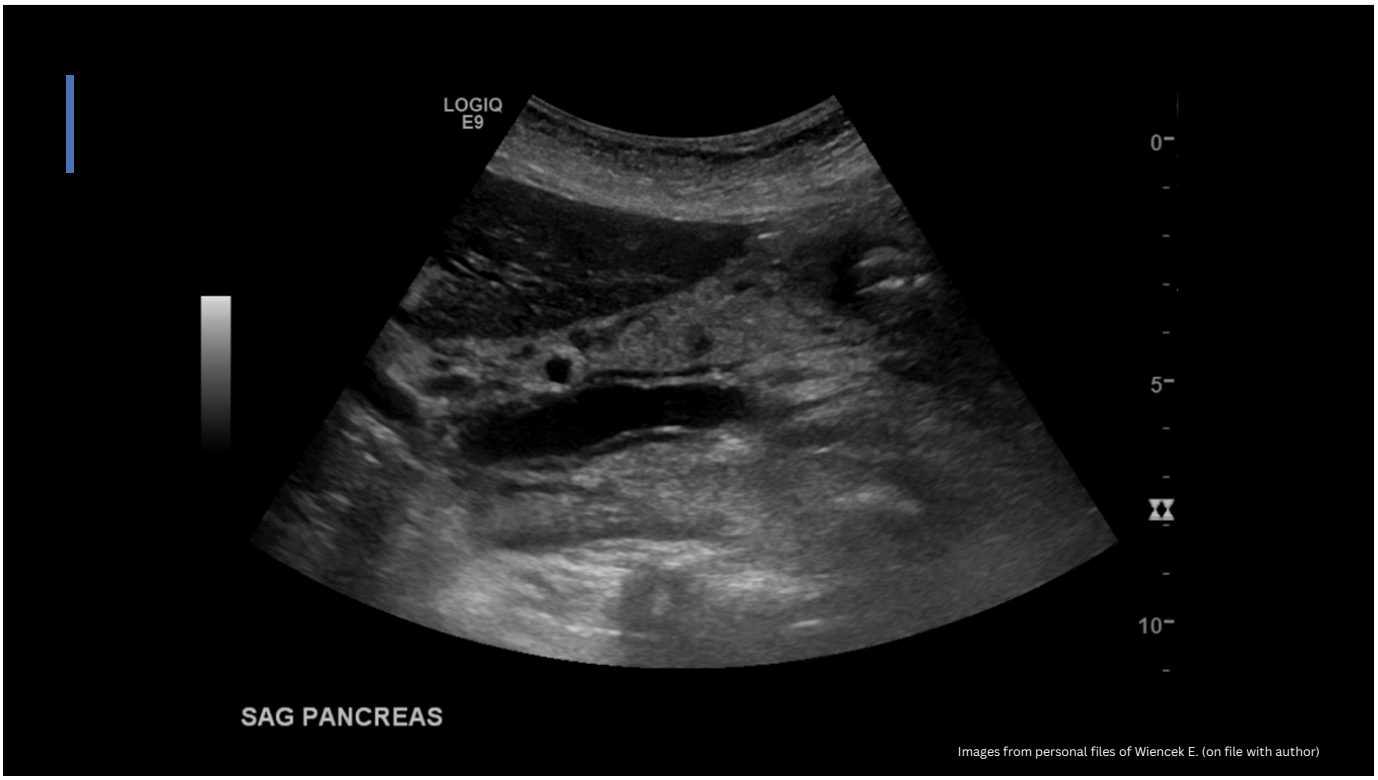

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CHRONIC PANCREATITIS

Symptoms -
- May be asymptomatic
- Oily, smelly stools (steatorrhea)
- Painless pancreatic insufficiency
- Weight loss
- Nausea and vomiting

Causes -
- Chronic biliary disease/obstruction
- Alcohol abuse
- Hypercalcemia and hyperlipidemia are risk factors

Labs -
- May have normal or amylase and lipase levels

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CHRONIC PANCREATITIS

Sonographic Findings -
- Focal or diffuse
- Small fibrotic gland
- Hyperechoic
- Mixed areas of hypo and hyper echogenicity
- Calcifications
- May have assoc. stones or thrombus
- Dilation of pancreatic duct
  - String of pearls appearance
  - Look for obstruction! without calc => look for mass

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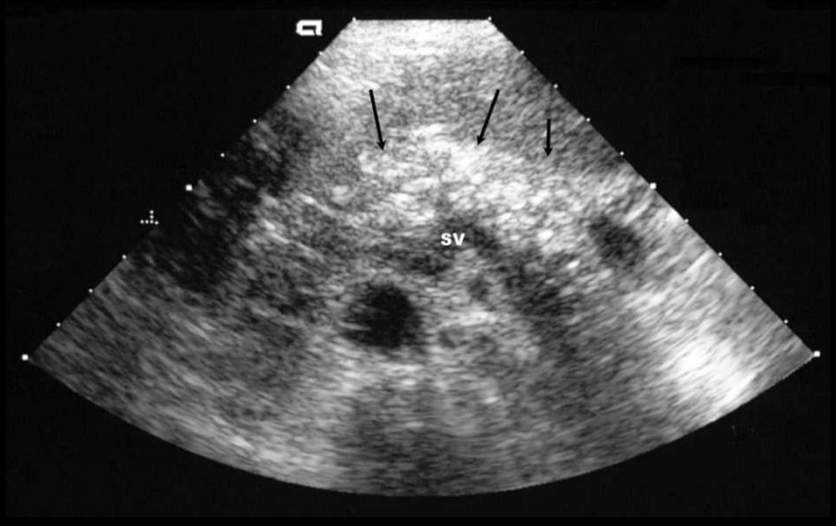
CHRONIC PANCREATITIS



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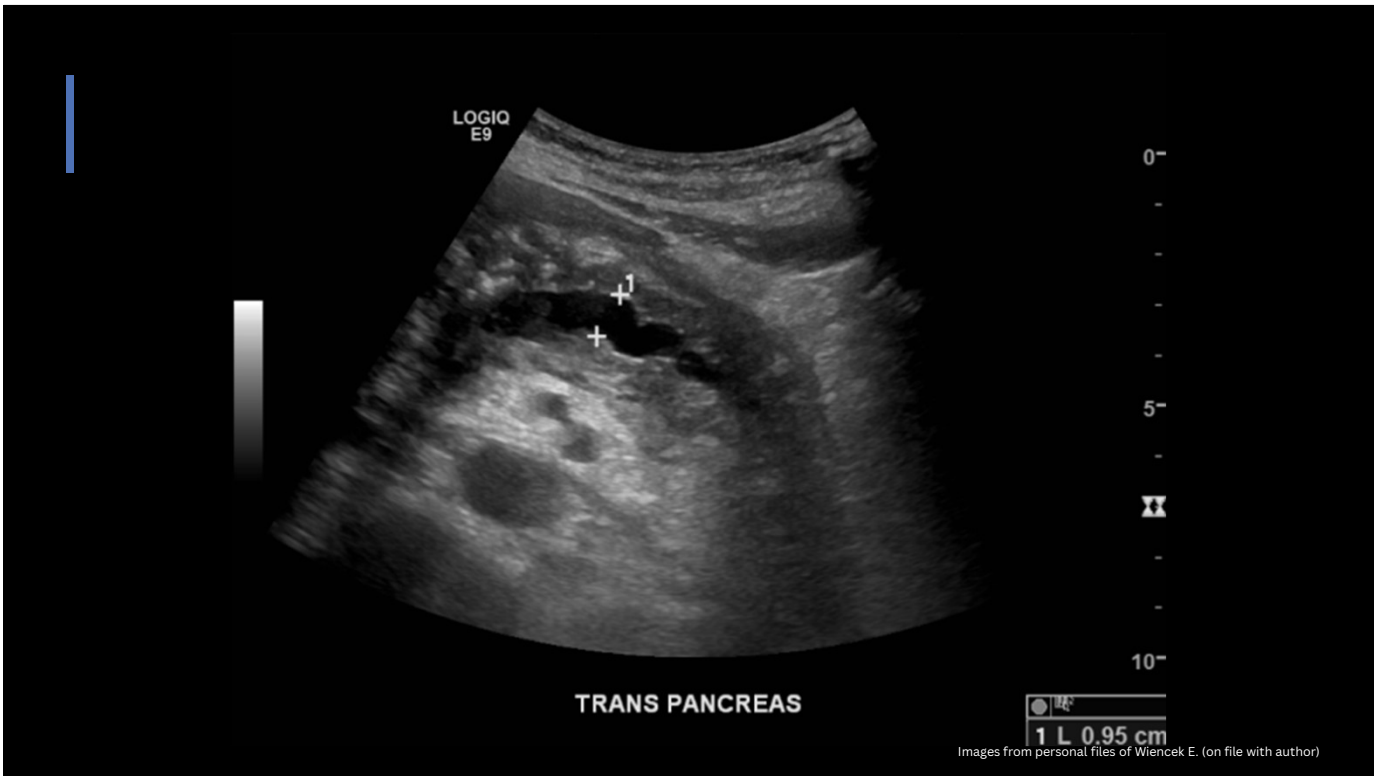

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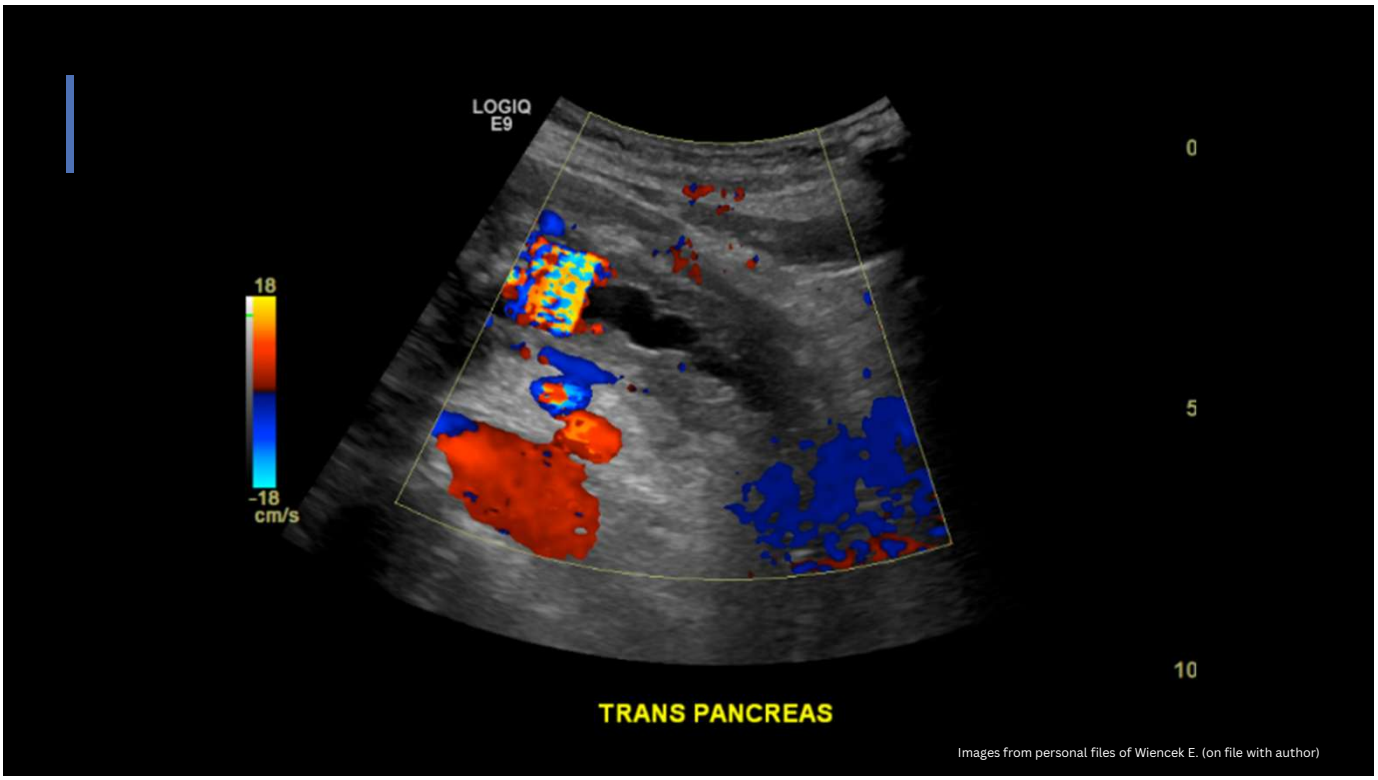

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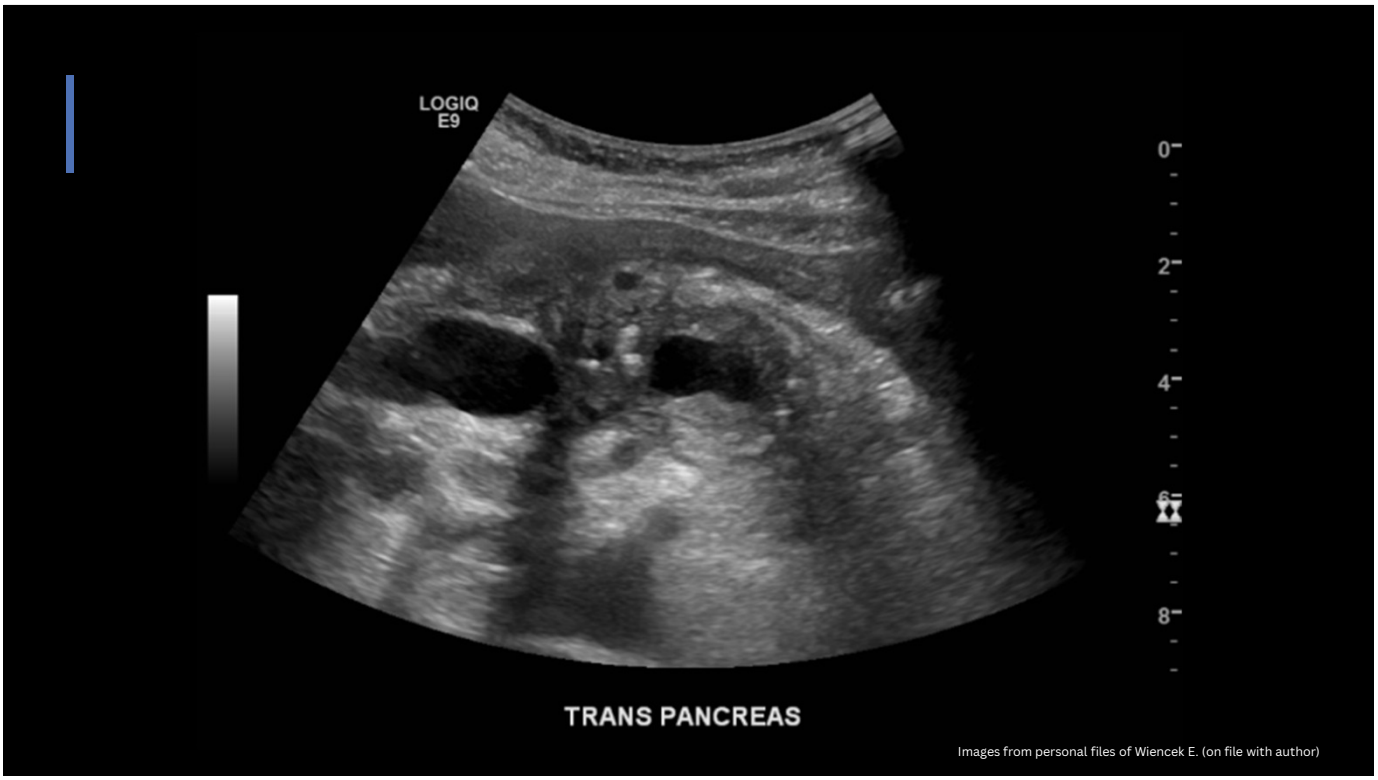

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IMAGING FOR CHRONIC PANCREATITIS

Endoscopic retrograde cholangiopancreatography (ERCP) -
- Gold standard and most accurate visualization of the pancreatic ductal system

Endoscopic ultrasound (EUS) -
- Can detect early disease not seen on CT scan, and can be used when CT and MR imaging are non-diagnostic

Magnetic resonance cholangiopancreatography (MRCP) and MRI -
- Can detect both parenchymal and ductal changes

Computed Tomography (CT)
- Best screening tool, essential to rule out mass or gastro-intestinal malignancy

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"EUS, ERCP, MRI and CT all have comparable high diagnostic accuracy in the initial diagnosis of CP. EUS and ERCP are outperformers and US has the lowest accuracy"

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COMPLICATIONS OF PANCREATITIS

- Fluid collections
- Pseudocysts
- Hemorrhagic pancreatitis
- Phlegmonous pancreatitis
- Pancreatic Abscess

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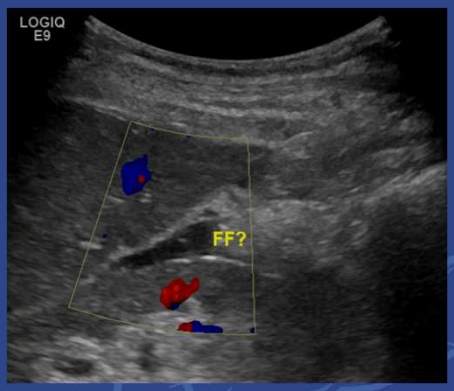
FLUID COLLECTIONS

Usually resolve spontaneously,

those that don't are pseudocysts

<u>Common sites:</u>

- Lesser sac
- Anterior pararenal spaces
- Mesocolon
- Perirenal spaces
- Peripancreatic soft-tissue spaces



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PSEUDOCYSTS

Develop 4 to 6 weeks after onset of pancreatitis and occur in 10% to 20% of patients

- Usually at lesser sac (ant. to pancreas and post. to stomach or anterior pararenal space (L>R)
- Can rupture causing pancreatic ascites leading to sudden shock and peritonitis
  - (Mortality rate is 50%)

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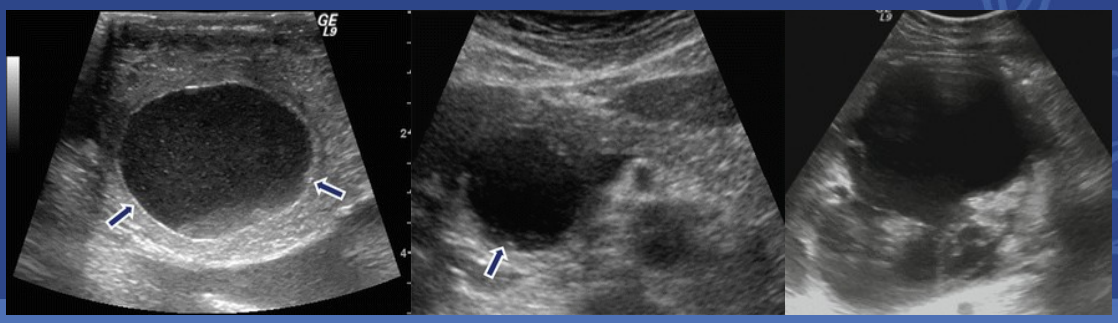
PSEUDOCYSTS

Sonographically-

- Hypoechoic or anechoic
- may have dependent debris



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HEMORRHAGIC PANCREATITIS

Rapid progression of acute pancreatitis with the rupture of pancreatic vessels and subsequent hemorrhage

Nearly half of these patients have sudden necrotizing destruction of the pancreas after an alcoholic binge or an excessively large meal.

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PHLEGMONOUS PANCREATITIS

Sonographically-

- Hypoechoic or anechoic
- may have dependent debris

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BENIGN CYSTIC LESIONS

- Autosomal Dominant Polycystic Disease
- von Hippel-Lindau Syndrome
- Cystic Fibrosis
- True Cysts

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AUTOSOMAL DOMINANT POLYCYSTIC DISEASE

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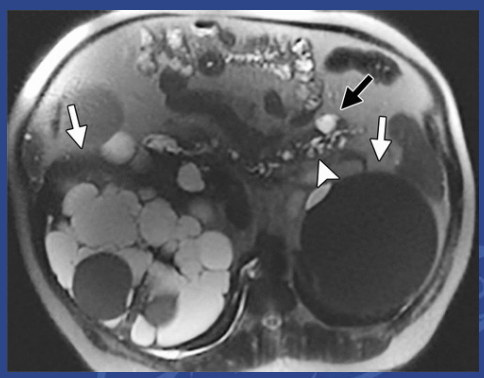
- Multiple small cysts in the kidney and liver
- Rarely can have extension into the pancreas
- Microscopic to several centimeters in size



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VON HIPPEL-LINDAU SYNDROME

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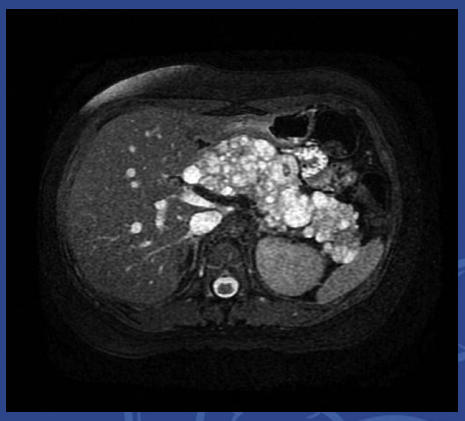
- Manifests in early adulthood but can occur throughout life
- Develop cysts in the kidneys, pancreas and genital tract
- Increased risk for pancreatic neuroendocrine tumor



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CYSTIC FIBROSIS

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- Fatty replacement which can progress to complete pancreatic lipomatosis
- May have calcifications
- Solitary to several cysts ranging from microscopic to several centimeters

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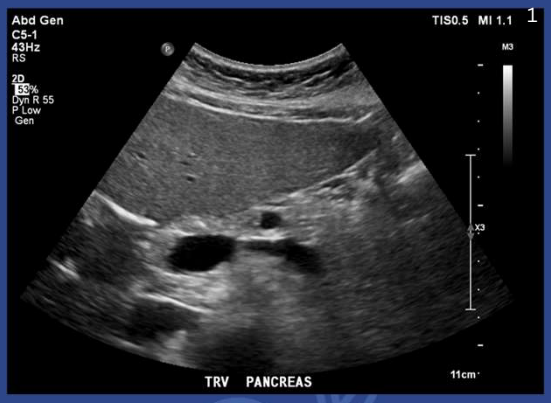
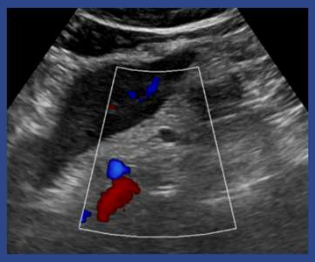
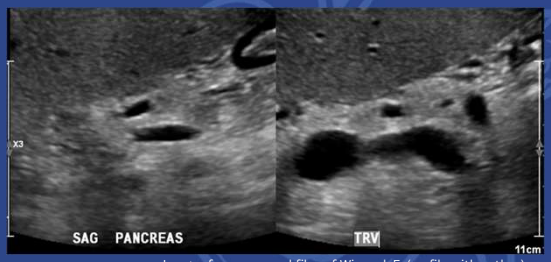
TRUE CYSTS

- Often found in infants
- May be unilocular or multilocular







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PANCREATIC TUMORS

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In 2025, an estimated

67,440

new cases of pancreatic cancer will be diagnosed in the US and

51,980

people will die from the disease

65

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Studies suggest that individuals at high risk for pancreatic cancer because of genetic predisposition or a strong family history can benefit from annual surveillance with endoscopic ultrasound and/or magnetic resonance imaging (MRI)

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For all stages combined, the 5-year relative survival rate is

13%

67

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It is currently the 3rd leading cause of cancer-related death in the United States after lung and colon and expected to become the 2nd by 2030

68

1

CYSTIC NEOPLASMS

Account for 10-15% of pancreatic cysts & 1% of cancers

4 subtypes:

- Serous cystic tumors
- Mucinous cystic tumors
- Intraductal papillary cystic tumors
- Solid pseudopapillary tumors

69

1

SEROUS CYSTIC TUMORS

- Rare benign tumor (serous cystadenoma)
- Elderly females
- Low malignant potential (serous cystadenocarcinoma)
- Difficult to differentiate from mucinous form

11

Sonographically-

- Multiple tiny cysts
- May appear cystic, solid, or echogenic
- May have thick walls
- Hypervascular capsule on doppler

11

70

MUCINOUS CYSTIC TUMORS

- Rare slow growing tumor
- Malignant (mucinous cystadenocarcinoma) or benign with high malignant potential (mucinous cystadenoma)
- Middle aged or elderly females
- Body or tail

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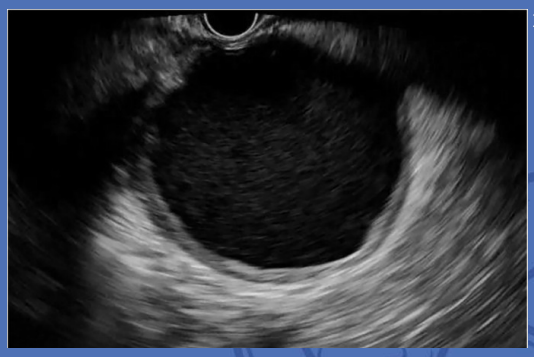
Sonographically-

- Well circumscribed
- Uni or multi-locular
- Thick mucinous fluid
- Poor survival rate for larger lesions



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INTRADUCTAL PAPILLARY CYSTIC TUMORS

- Form of mucinous cystic neoplasm
- Elderly men and women
- Benign or malignant
- Ductal origin

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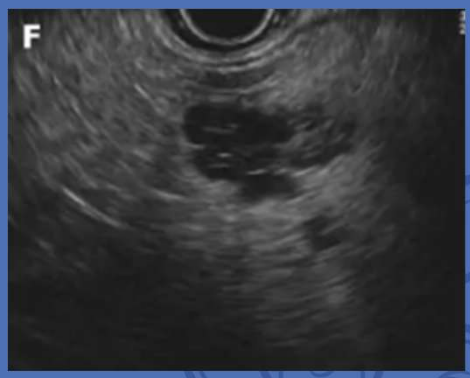
Sonographically-

- Dilated pancreatic duct
- Vascular if malignant form
- Single cyst or multicystic



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SOLID PSEUDOPAPILLARY TUMORS

- Young woman
- Lower incidence of malignancy
- Small in size, usually visualized on MRI

1

Sonographically-

- Solid and cystic components

12

73

ENDOCRINE NEOPLASMS

1

Functional

- Insulinoma (B-Cell tumor)
- Gastrinoma (G-Cell tumor)

Nonfunctional

- Adenocarcinoma

Islet cell tumors

74

INSULINOMA

- Most common functional tumor
- 4th- 6th decade of life
- Hypoglycemic symptoms with relief with glucose

1

Sonographically-

- Solid well defined hypoechoic lesion
- Small
- Homogenous echotexture

13

75

GASTRINOMA

- 60% are malignant
- 40% have metastasized at diagnosis
- Young adults
- Frequently multiple
- Can be extrapancreatic

ZOLLINGER-ELLISON SYNDROME:

gastrin secreting tumor causes overproduction of gastric acid, leading to recurrent peptic ulcers

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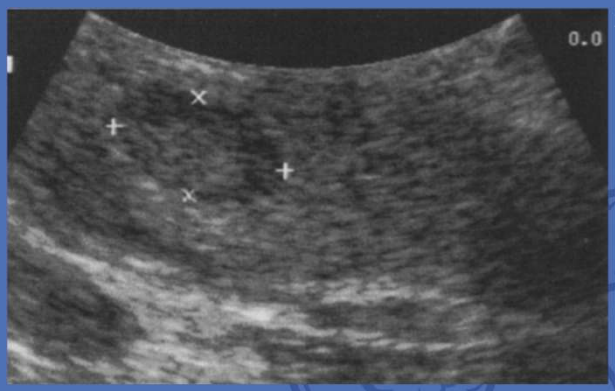
Sonographically-

- Solid
- Hypervascular
- Small
- Difficult to locate



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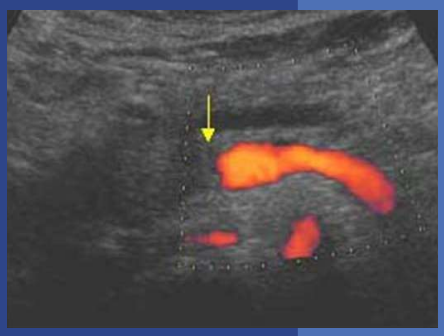
ADENOCARCINOMA

- Accounts for more than 90% of all malignant pancreatic tumors
- Jaundice
- GB hydrops
- Weight loss
- Pain



Sonographically-

- Ill defined mass
- Iso to hypoechoic
- Ductal dilation

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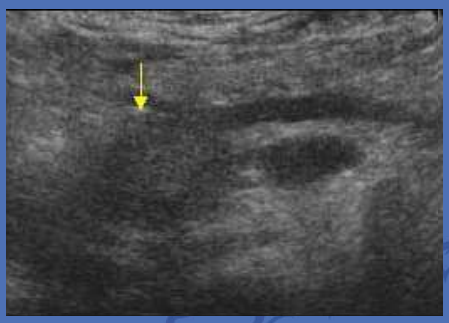

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PARAPANCREATIC NEOPLASMS

- Lymphoma (#1)
- Lymphangiomas
- Paragangliomas
- Cystic teratomas
- Metastases

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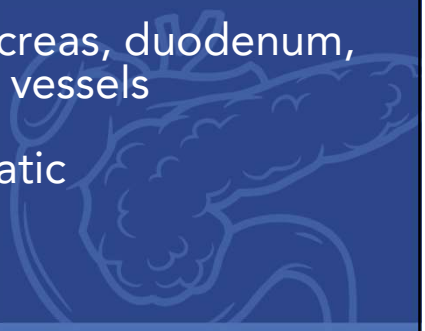
LYMPHOMA

- Malignant neoplasm
- Appear as a hypoechoic mass, a cystic mass, or with necrosis
- Multiple nodes are seen along the pancreas, duodenum, porta hepatis, and superior mesenteric vessels
- Difficult to distinguish from peripancreatic lymphadenopathy



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METASTATIC DISEASE

Metastasis to the pancreas is uncommon (10%)

Primary sites:

- Melanomas
- Breast
- Gastrointestinal
- Lung

80

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PATIENT DEMOGRAPHICS

Age: 86
Sex: Female

No clinically significant history
No history of smoking, alcohol or drug abuse

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SYMPTOMOLOGY/LABS

Jaundice for 3 weeks
Denies any abdominal pain

Total Bilirubin:	19.4 (0.1 to 1.2 mg/dL)
AST:	169 (14-36 U/L)
ALT:	177 (4-34 U/L)
ALP:	359 (38-126 U/L)
Amylase:	73 (30-110 U/L)
Lipase:	121 (23-300 U/L)

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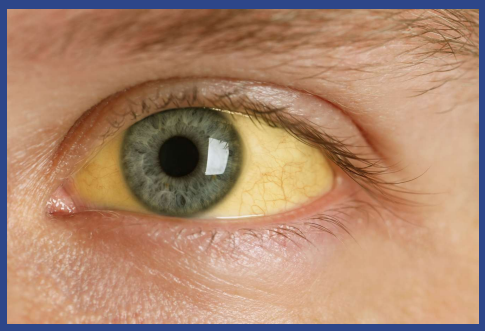
IMAGING

Ultrasound ordered for jaundice



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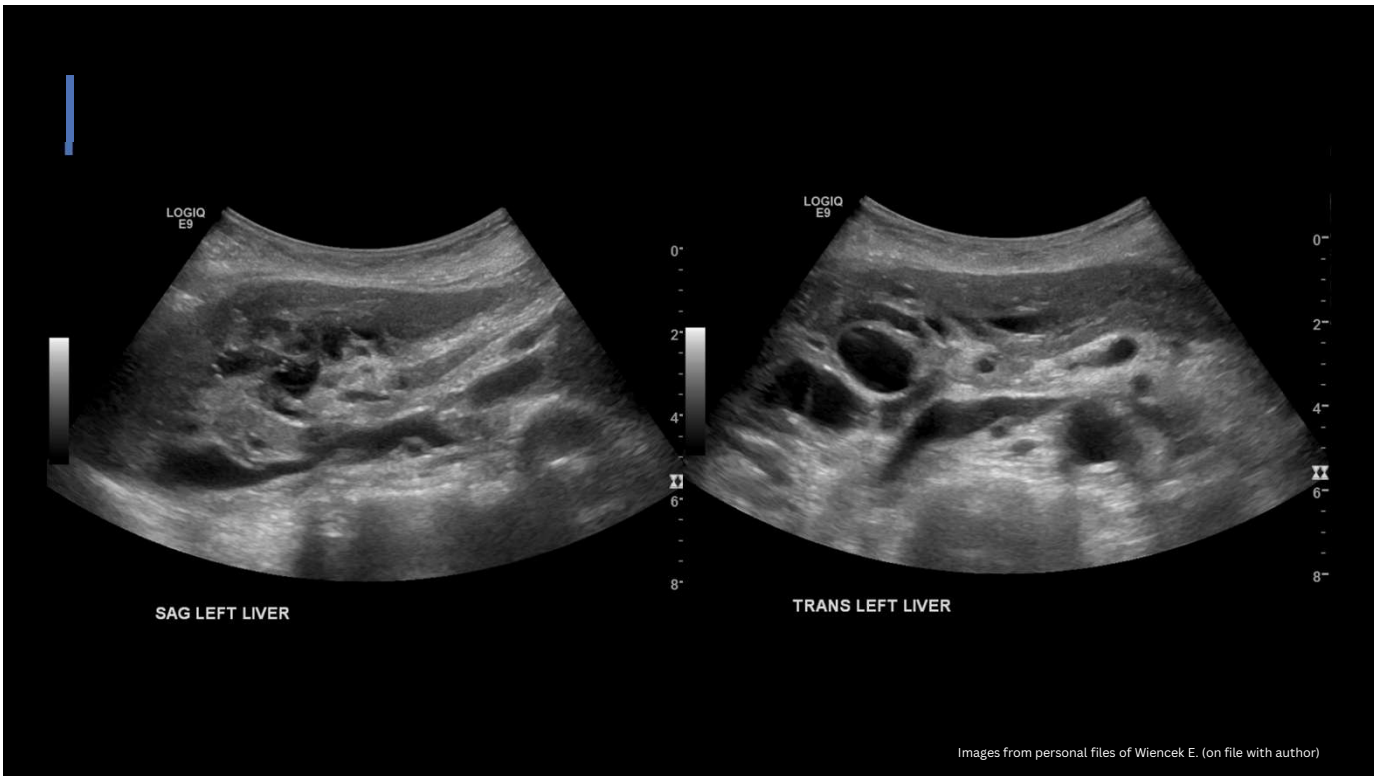

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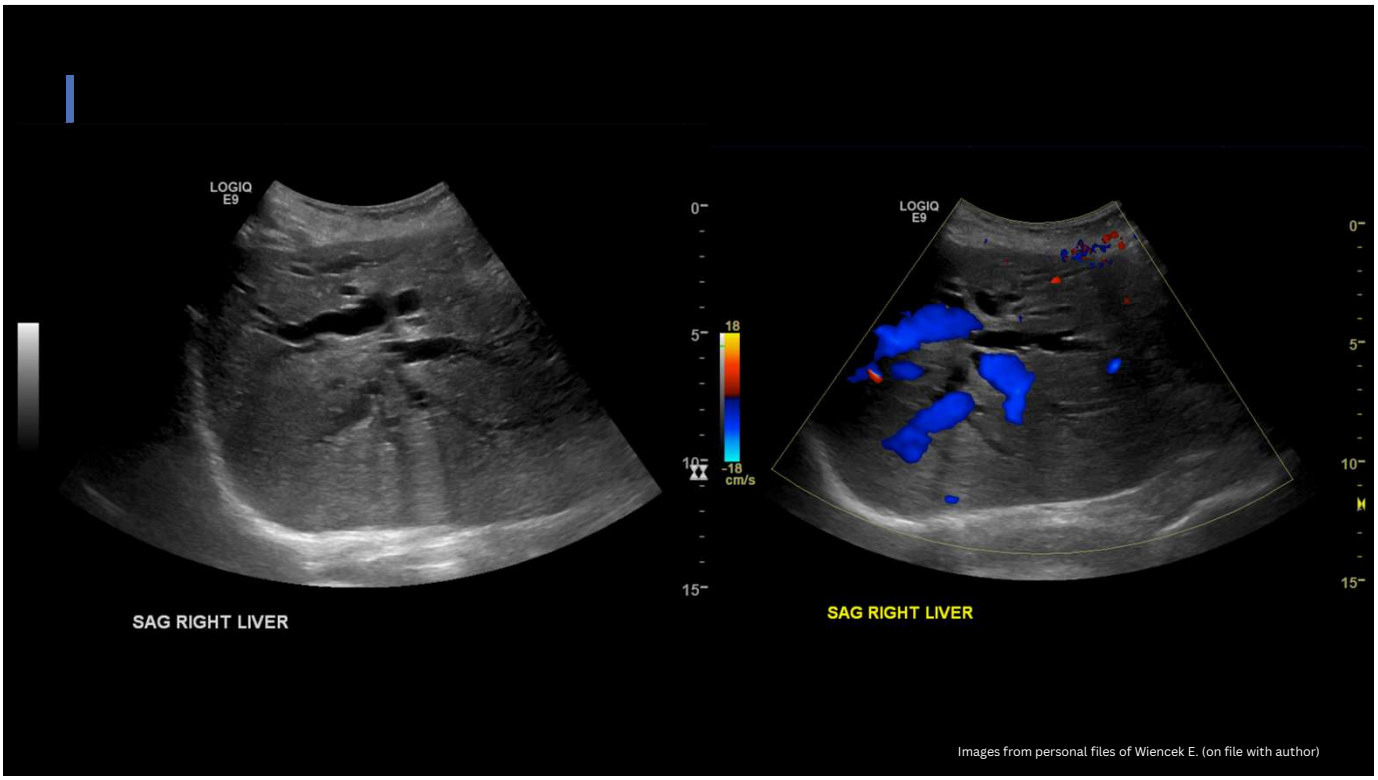

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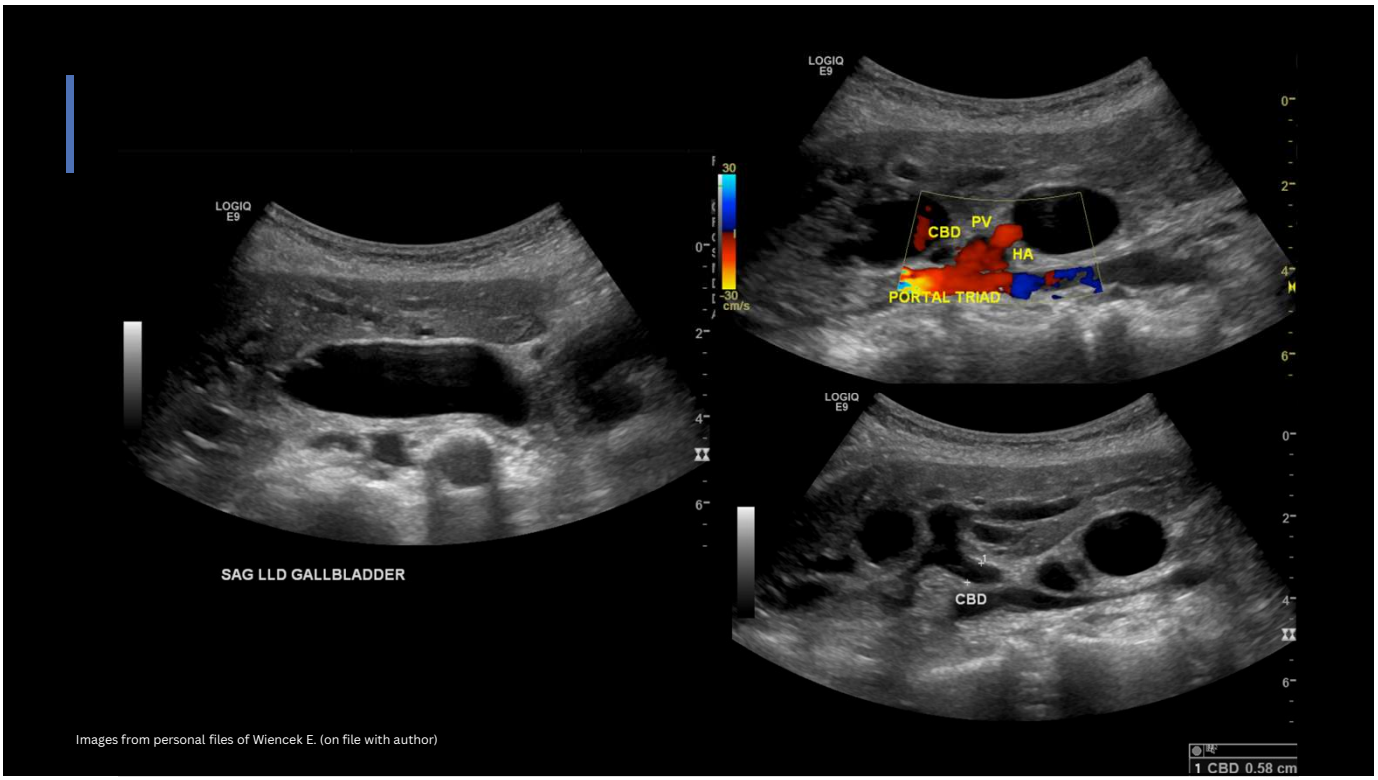

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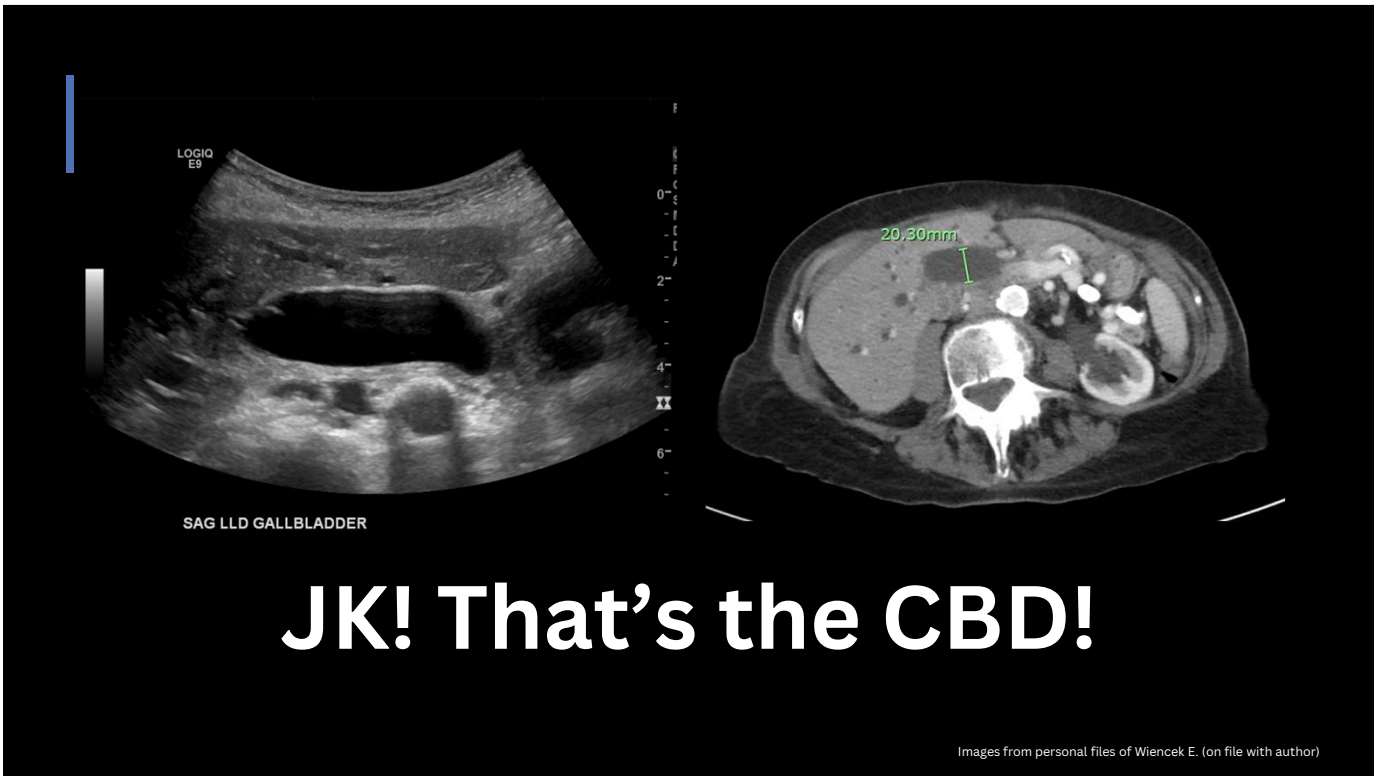

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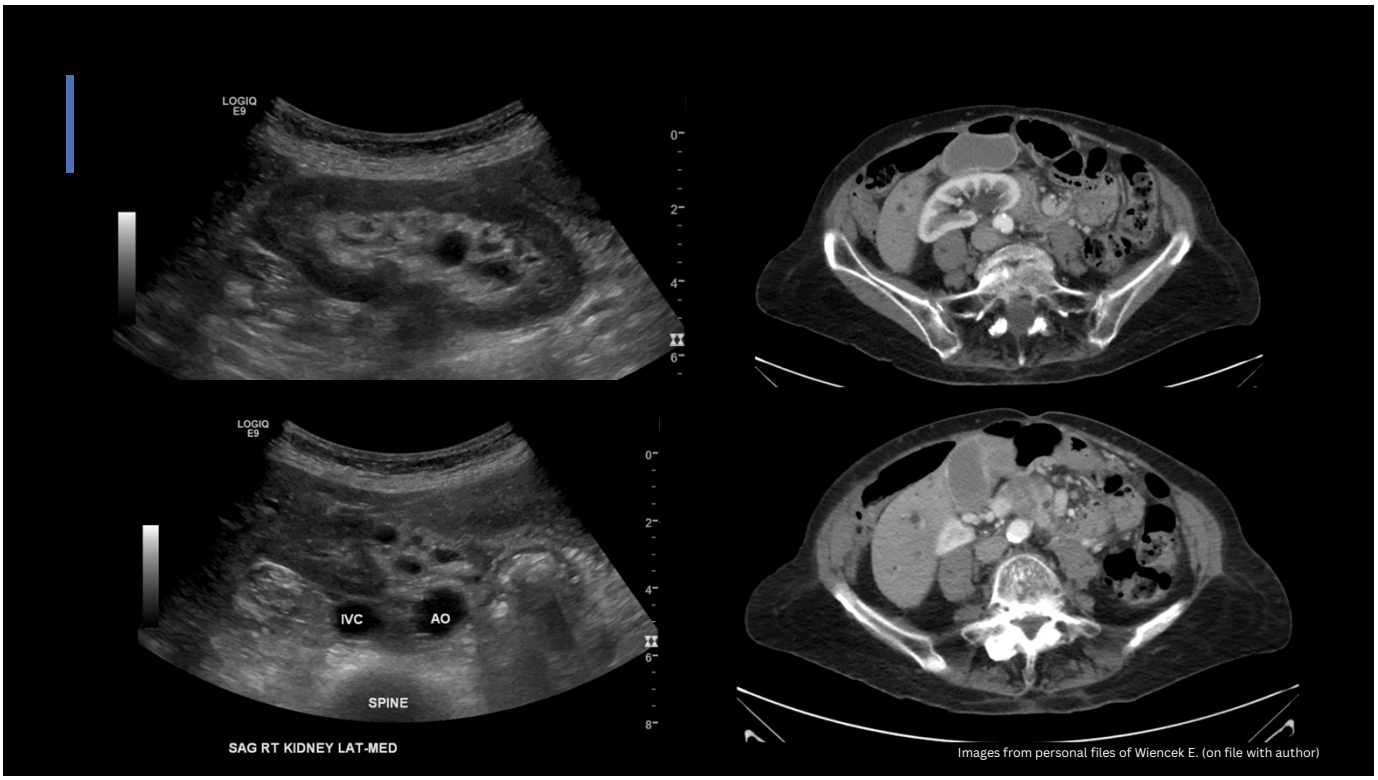

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Where is the cause?
Back to the pancreas!

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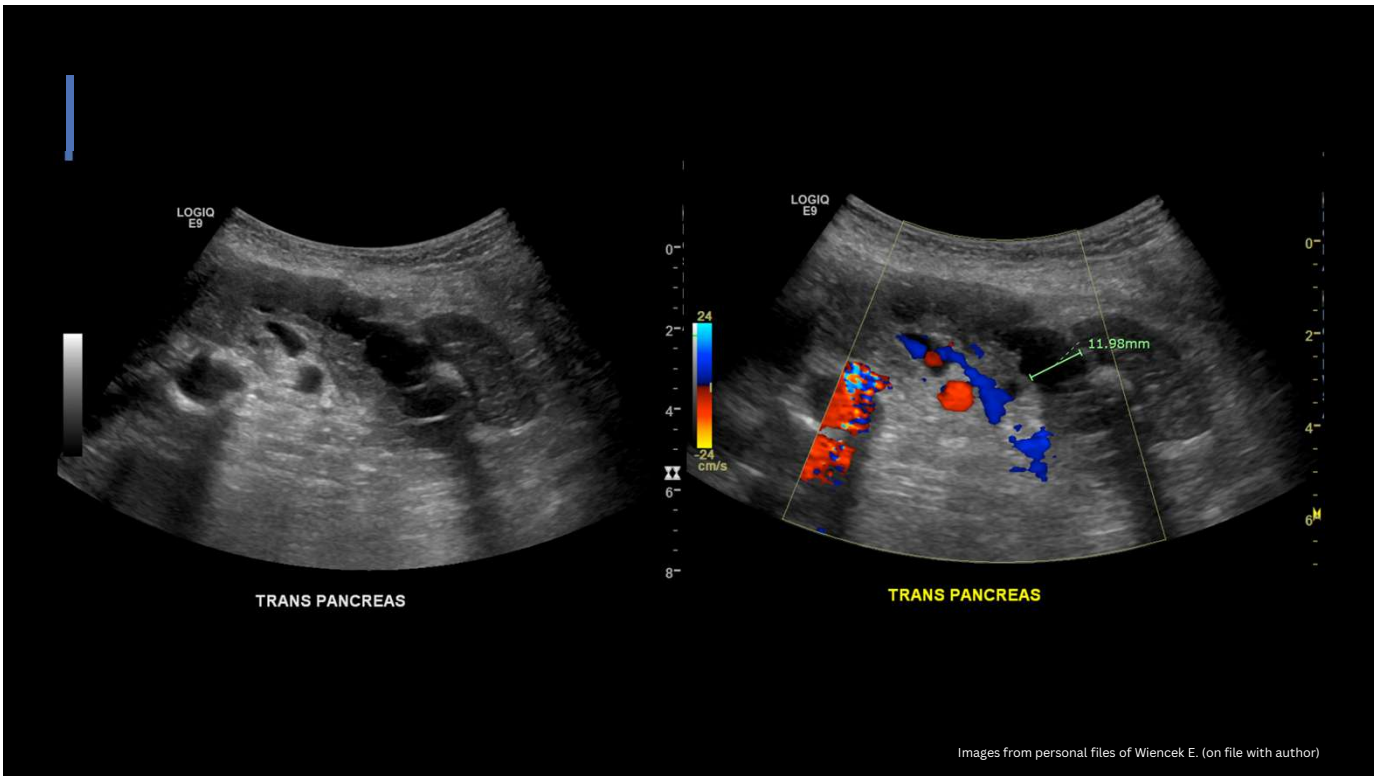

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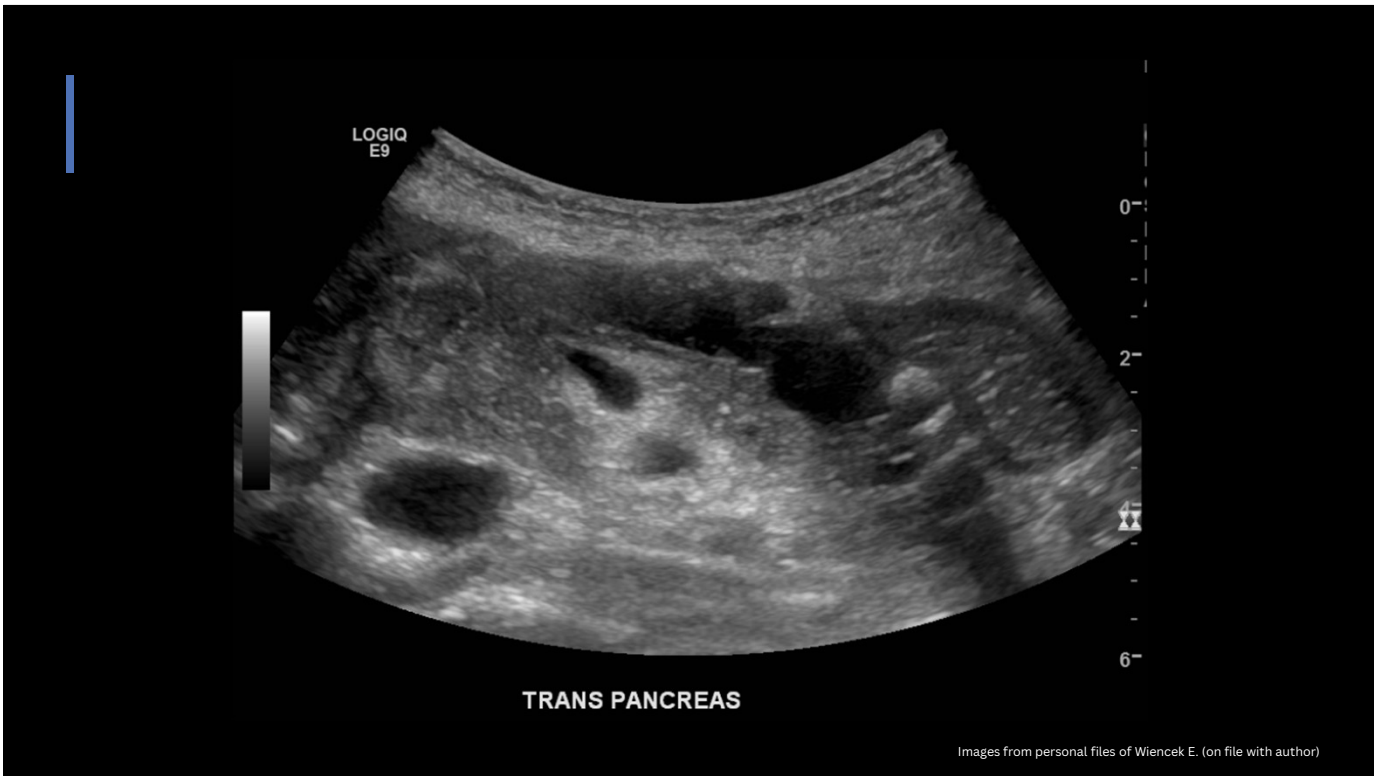

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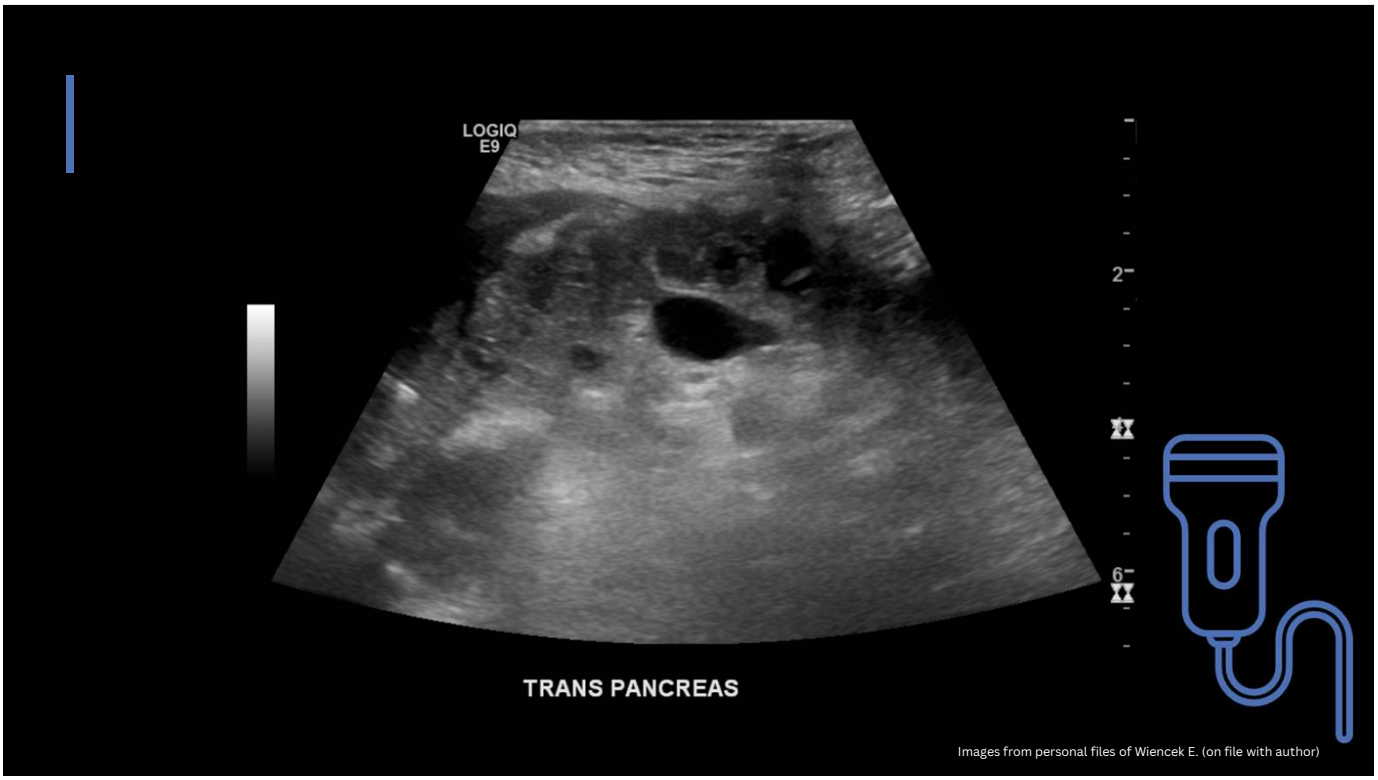

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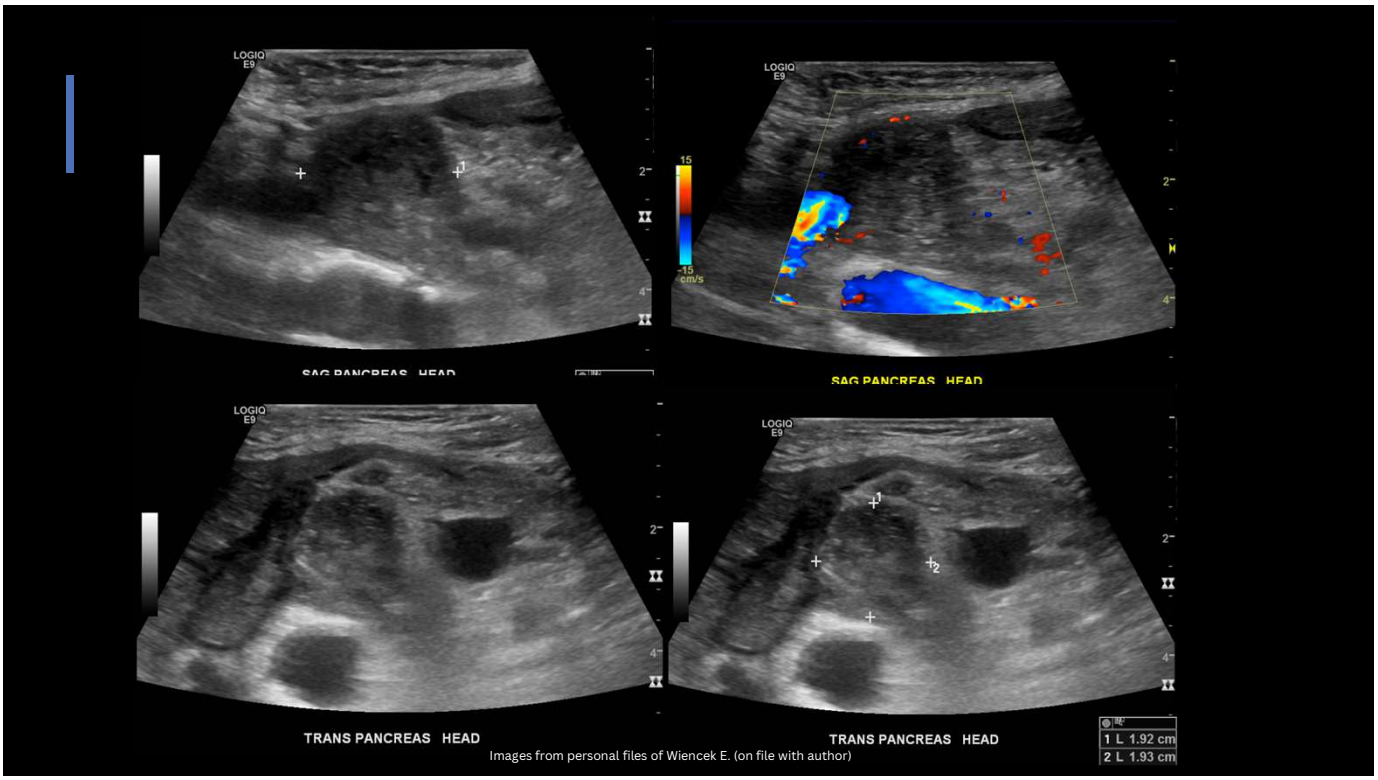

Images from personal files of Wiencek E. (on file with author)

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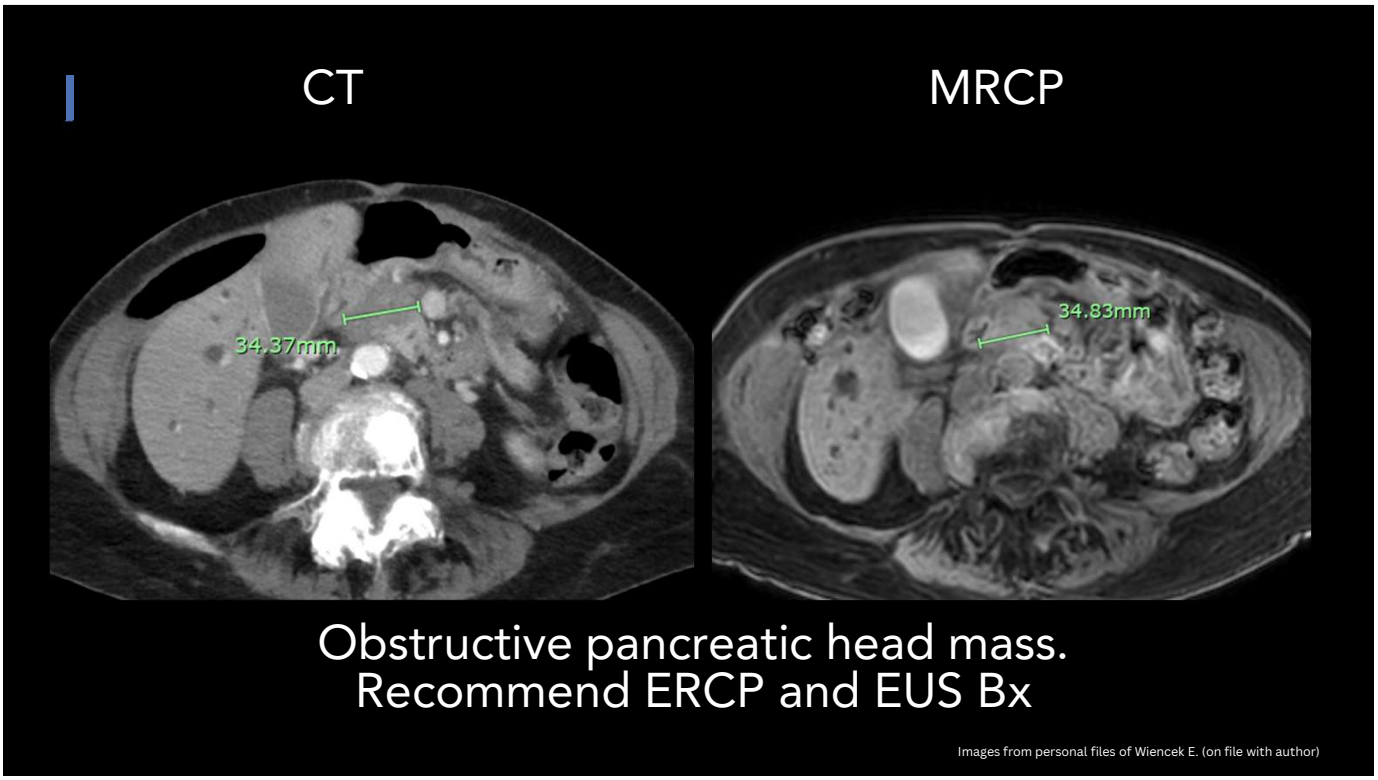

Obstructive pancreatic head mass.
Recommend ERCP and EUS Bx

Images from personal files of Wiencek E. (on file with author)

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DIAGNOSIS?

Adenocarcinoma

Patient passed 30 days after being seen in the ER

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TAKEAWAYS

- While ultrasound isn't always the gold standard, it can be a great tool when used effectively
- Understanding relational anatomy, and knowing techniques to optimize visualization of the pancreas are important
- We can find things early and alert the ordering providers to further investigate our findings

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THANK YOU

Any questions?

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