Abdominal Ultrasound
Chapter 6

THE PANCREAS

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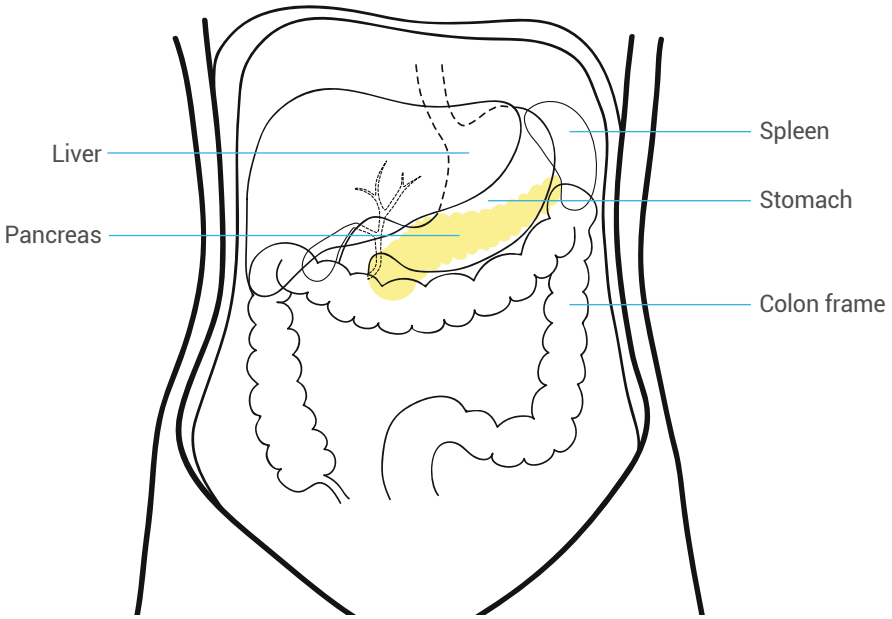
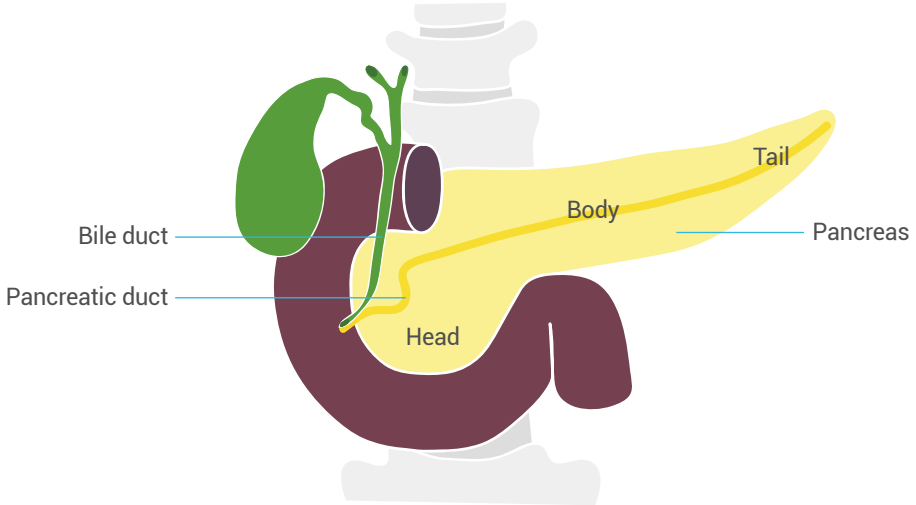
The Pancreas

MASTERING ULTRASOUND ANATOMY

The pancreas is located in the retroperitoneum, surrounded by retroperitoneal fat. It has a transverse orientation, with the head of the pancreas lying just in front of the upper lumbar vertebral column and its tail directed cranially and laterally into the hilum of the spleen.

The pancreas is an excretory organ, which produces exocrine digestive fluids as well as endocrine hormones (e.g., insulin, glucagone, etc.).



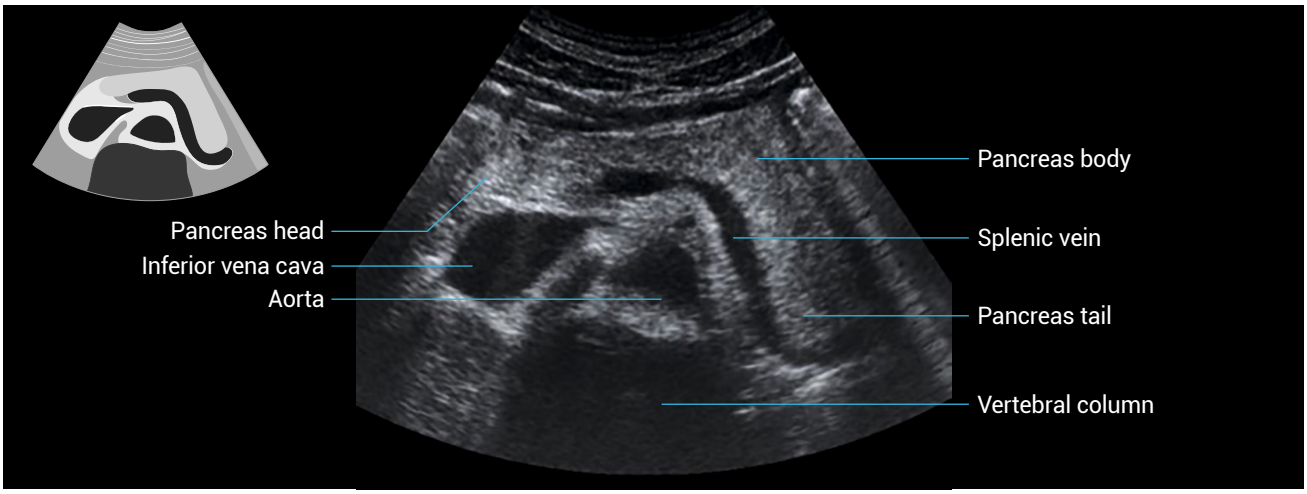


The pancreatic duct transports the exocrine fluids through the papilla vateri into the duodenum.

Anatomy

The image below shows a cross section over the median epigastric region showing the pancreas head, body, and tail.

The pancreas receives its blood supply from many small branches originating from the splenic artery. The venous drainage occurs via the splenic vein.



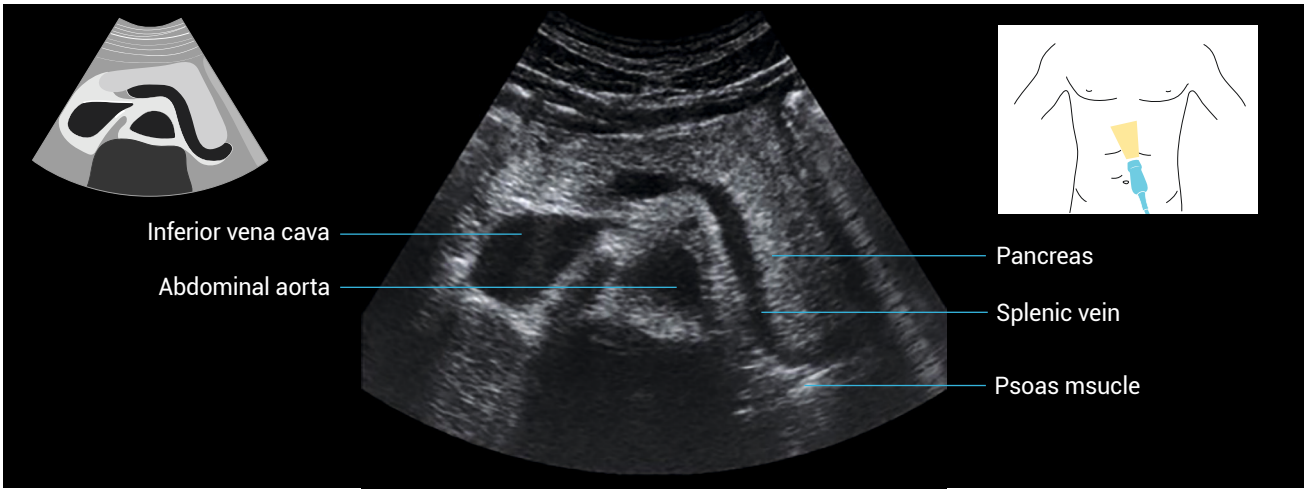
The Pancreas

RECOGNIZING THE LANDMARKS

Pancreas–long section

In ultrasound studies of the pancreas, one of the most important landmarks is the splenic vein. In long section, it runs parallel to the pancreas body.

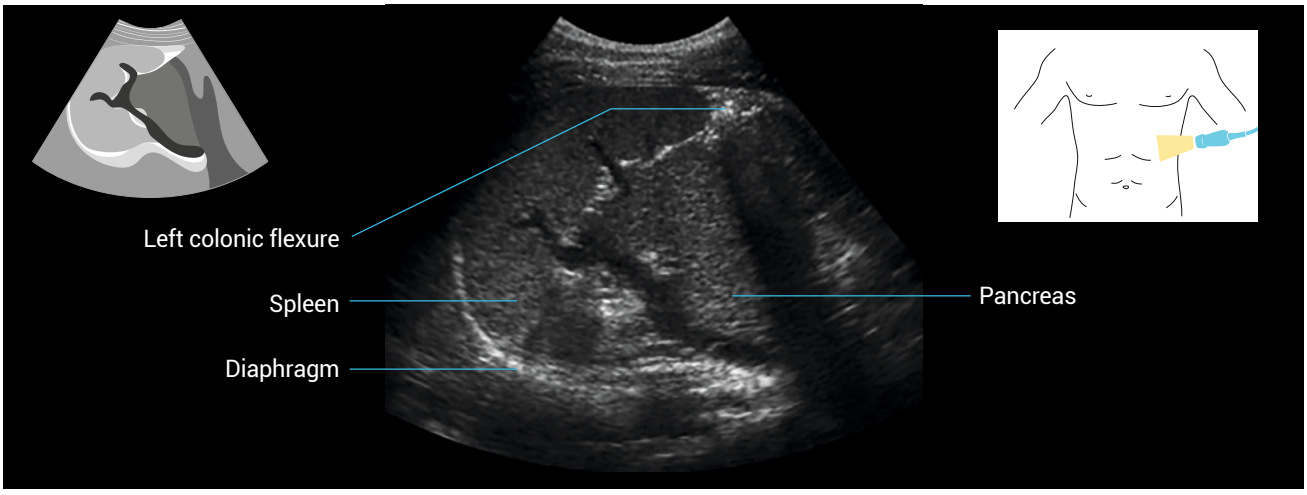
The pancreas body can be seen in long section directly ventral to the splenic vein.



Splenic window–long section

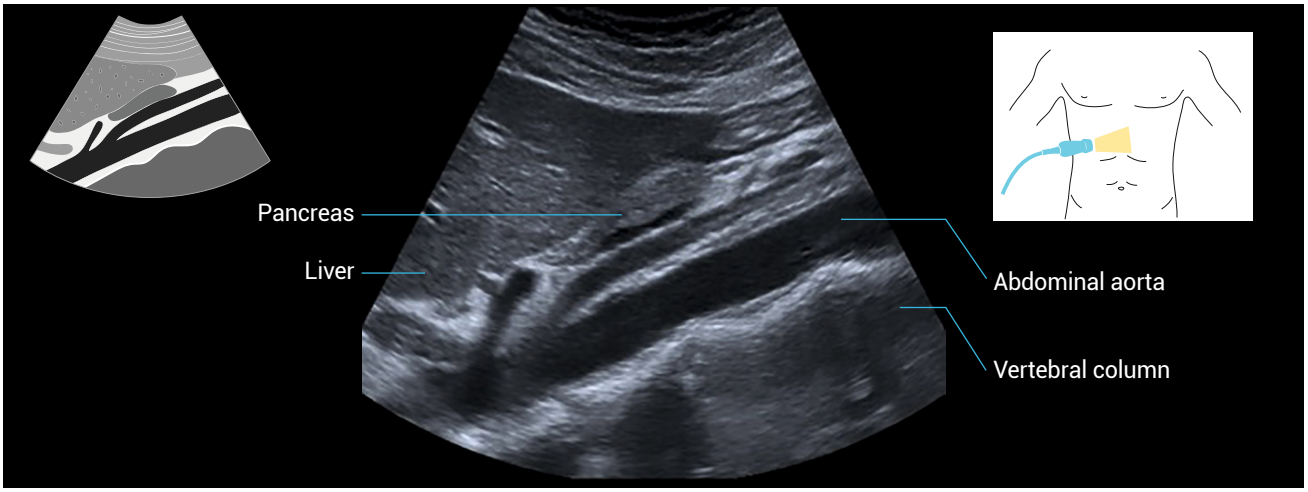
Examining the pancreatic tail can be difficult, and sometimes impossible, if the patient is obese or has eaten recently.

An alternative is to image using the splenic window. This procedure involves using the long section view of the spleen to find the pancreas tail. You will see it sitting right next to the splenic hilum.



Pancreas–cross section

Placing your probe in long section, medially over the patient's torso will allow you to image the pancreas in cross section. In this view, you can examine fluid collection in the omental bursa.



The Pancreas

HOW DO I DO IT?

Suggested algorithm for the ultrasound of the biliary system

1. Pancreas long section. Position your probe horizontally on the torso, then rotate 30° to align with pancreas

2. Splenic window. Position your probe longitudinally between the 9th or 10th intercostal space to image the pancreas tail in the splenIC window

3. Pancreas in cross section. From the long section of the pancreas, rotate the probe 90°

4. Landmarks: splenic vein in long section, splenic hilum

Important:
Always follow the same sequence!

The Pancreas

DIAGNOSING PANCREATITIS

Acute pancreatitis

Pancreatitis refers to inflammation involving the pancreas.

It has various forms which can be classified according to time of onset, etiological agent, or associated pathology.

Acute pancreatitis refers to acute onset inflammation of the organ and can present in two different forms, which differ in severity.

- Interstitial or edematous pancreatitis represents the vast majority (90–95%) of cases and is most often referred to simply as acute pancreatitis or uncomplicated pancreatitis.
- Necrotizing pancreatitis—necrosis develops within the pancreas and / or peripancreatic tissue.

The diagnosis of acute pancreatitis is made by fulfilling two of the following three criteria:

1. Acute onset of persistent, severe, epigastric pain (i.e., pain consistent with acute pancreatitis).

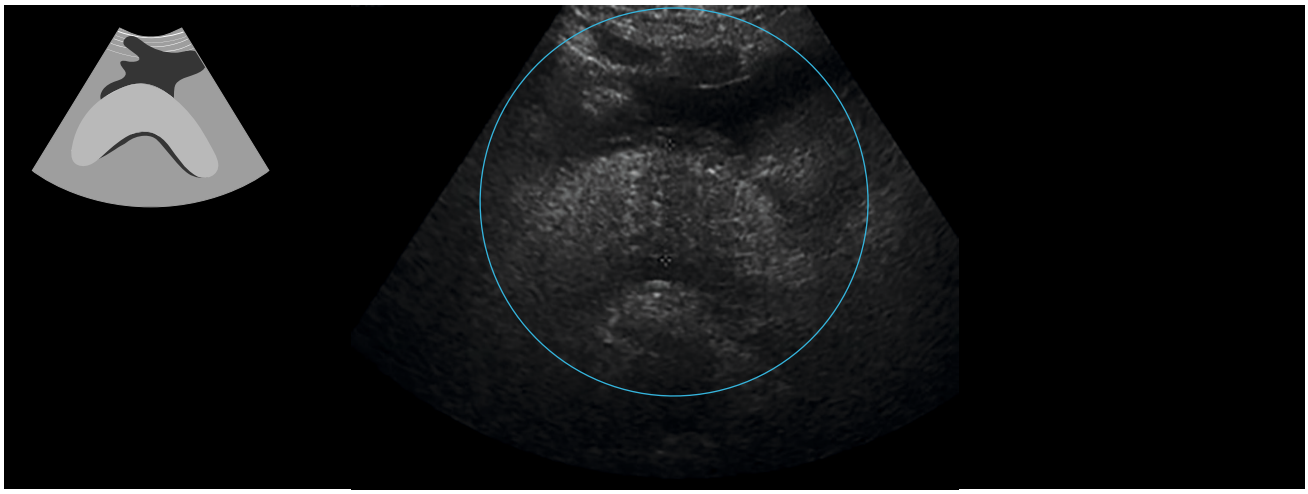
2. Lipase / amylase elevation three times the upper limit of normal.

3. Characteristic imaging features.

Edematous pancreatitis

Typical ultrasound findings of acute edematous pancreatitis include thickening of the organ (swelling), sonopalpable pain, and, in more severe forms, fluid collection in the omental bursa.

Imaging is only required to establish the diagnosis if the other two diagnostic criteria (outlined above) are not met. Imaging is crucial for the detection of complications and to help guide treatment.



Necrotizing pancreatitis

Necrotizing pancreatitis is the more severe form of acute pancreatitis. In these cases, the vascularity of the pancreatic tissue is compromised because of the high level of inflammation.

In the presence of inflammation, necrotic tissue can be distinguished from the normal echogenic pancreatic tissue based on its lower echogenicity.

The loss of signal in color Doppler imaging is typical when examining the necrosis.

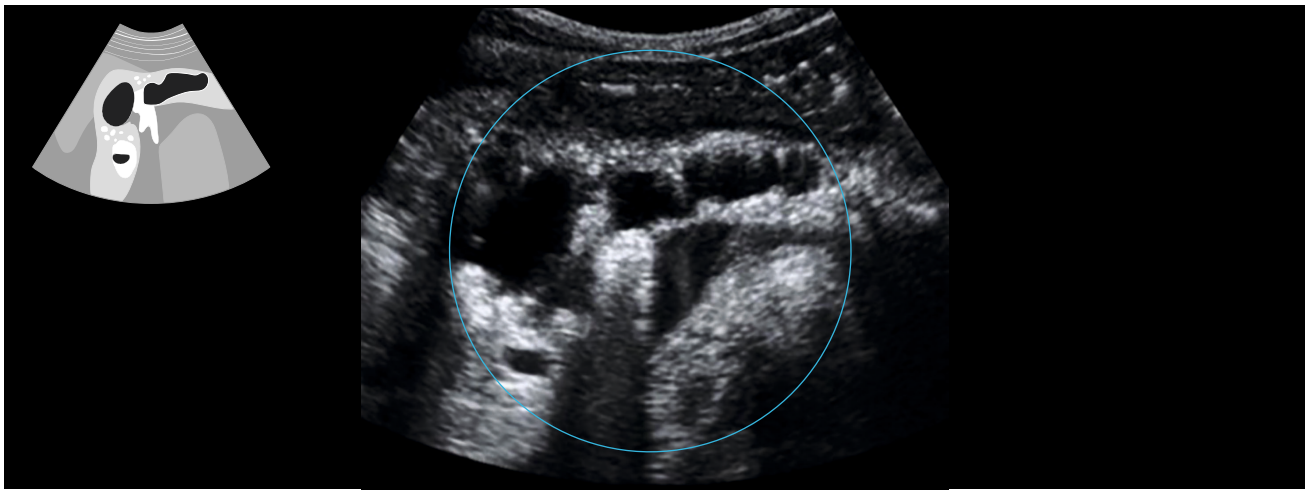
Chronic pancreatitis

Chronic pancreatitis represents a continuous, prolonged, inflammatory, and fibrosing process that affects the pancreas. Irreversible morphologic changes and permanent endocrine and exocrine pancreatic dysfunction are present.

Upon imaging, the pancreas might appear atrophic, calcified, or fibrotic.

Findings that may be present on ultrasound include

- Hyperechogenicity (often diffuse), which often indicates fibrotic changes
- Pseudocysts
- Pseudoaneurysms of splenic artery
- Presence of ascites



DIFFERENTIATING CYSTIC TUMORS OF THE PANCREAS

Serous cystadenoma

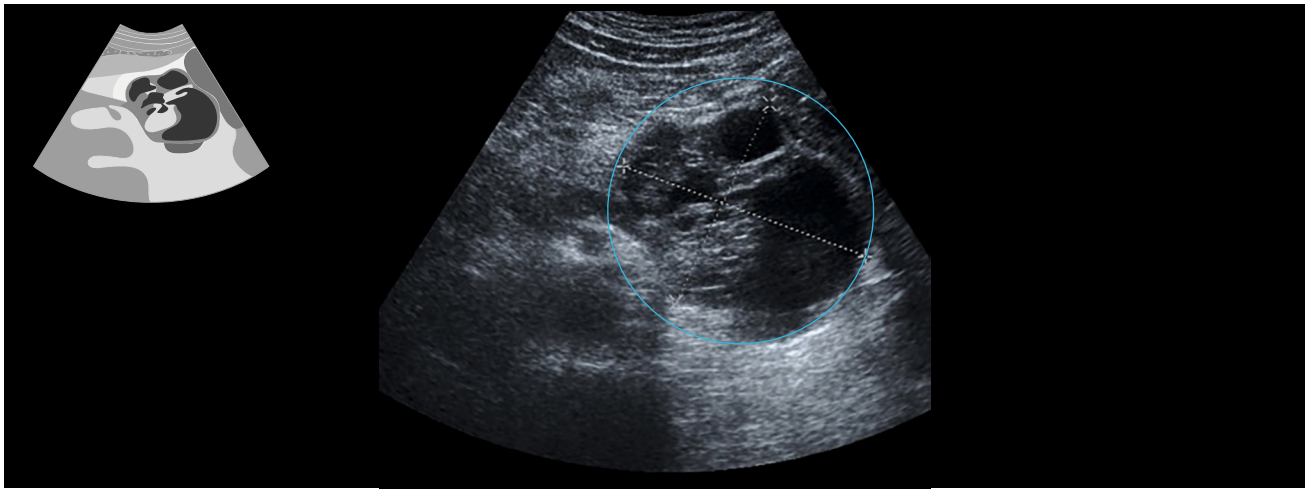
Serous cystadenoma of the pancreas (or microcystic adenoma) is an uncommon type of benign cystic pancreatic neoplasm.

It affects females approximately four times more often than males and usually presents in patients over 60 years of age.

Pancreatic serous cystadenomas are benign neoplasms composed of numerous small cysts that are arrayed in a honeycomb-like formation. There can be significant variation in cyst size (1–20 mm).

Three morphological patterns have been described

- Polycystic (70%)
- Honeycomb (20%)
- Oligocystic (macrocystic variant) (< 10%) (cysts can be larger than 20 mm)

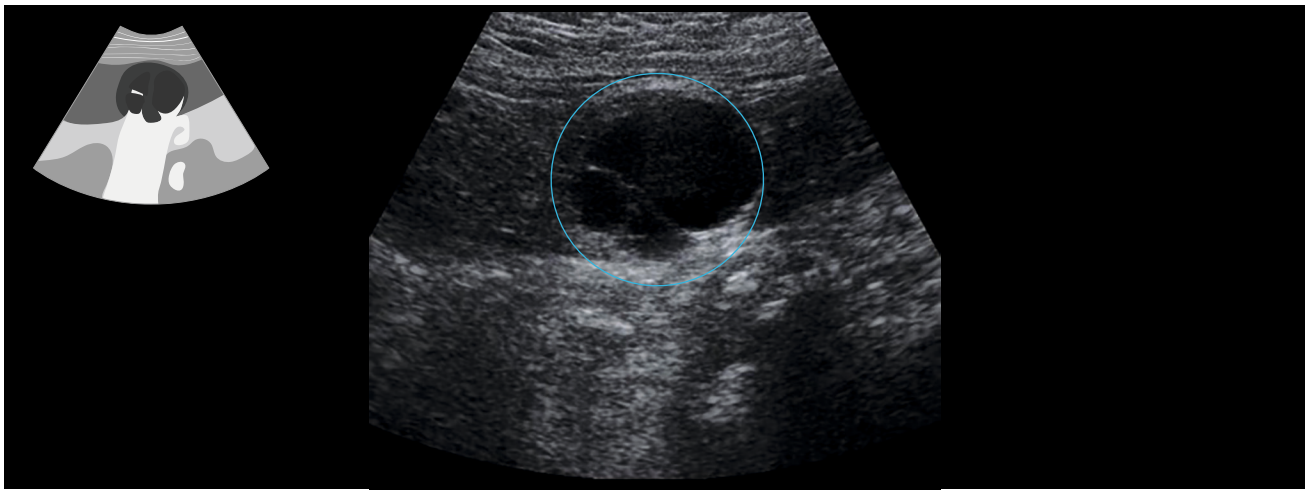


Mucinous cystadenoma

Mucinous cystadenoma was previously believed to occur exclusively in middle age females; however, it has occasionally been described in males.

It is a large unicular / multilocular cystic pancreatic neoplasm lined by columnar mucinous epithelium. While mucinous cystadenomas very infrequently communicate with the pancreatic duct, they can cause partial pancreatic ductal obstruction.

Most mucinous cystadenomas (~ 80%) occur in the body or tail of the pancreas, and less commonly in the head (~ 20%).

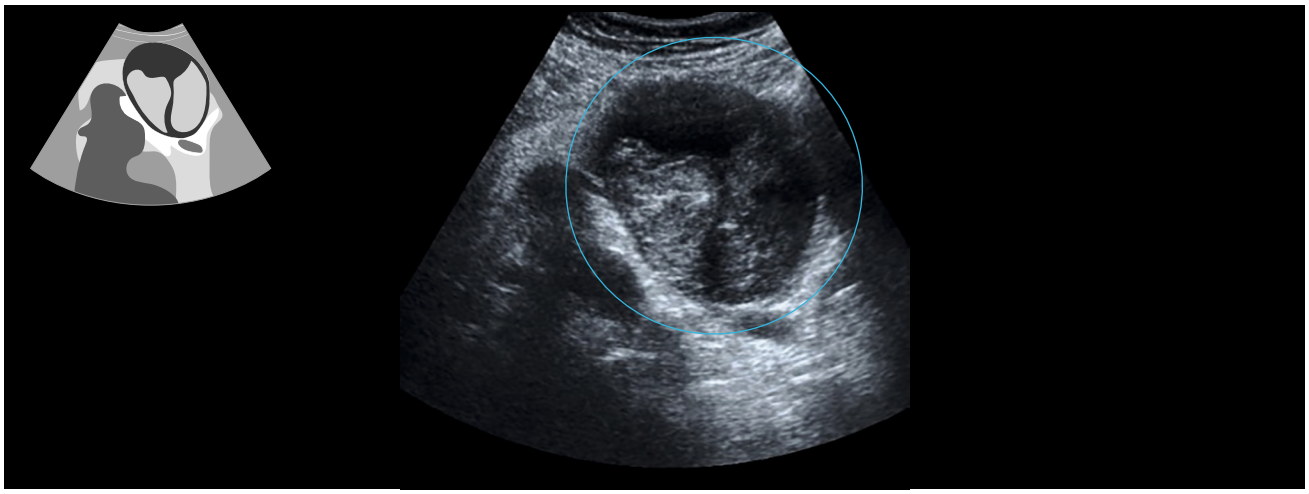


Mucinous cystadenocarcinoma

Mucinous cystadenocarcinomas of the pancreas are considered the more malignant counterpart of a mucinous cystadenoma.

Like the more benign mucinous cystadenomas, these are found almost exclusively in females.

These tumors are typically seen as a cystic pancreatic lesion with cysts that are less numerous and larger in size (with an average diameter of ~ 10–12 cm) than those typically observed with serous cystadenomas / cystadenocarcinomas. The external surface of these tumors is often smooth, and is composed of large (> 2–4 cm) unilocular or multilocular cysts with a thickened wall.



Intraductal papillary mucinous neoplasm

These tumors are most frequently identified in older patients (50–60 years of age). On average, main duct tumors (see below) present a decade or so earlier than branch duct tumors.

Intraductal papillary mucinous neoplasms are one of a number of mucinous tumors of the pancreas, and can be further divided based on their histological and macroscopic appearance. They are uncommon ductal epithelial tumors comprising approximately 10–15% of cystic pancreatic neoplasms.

Main duct tumors

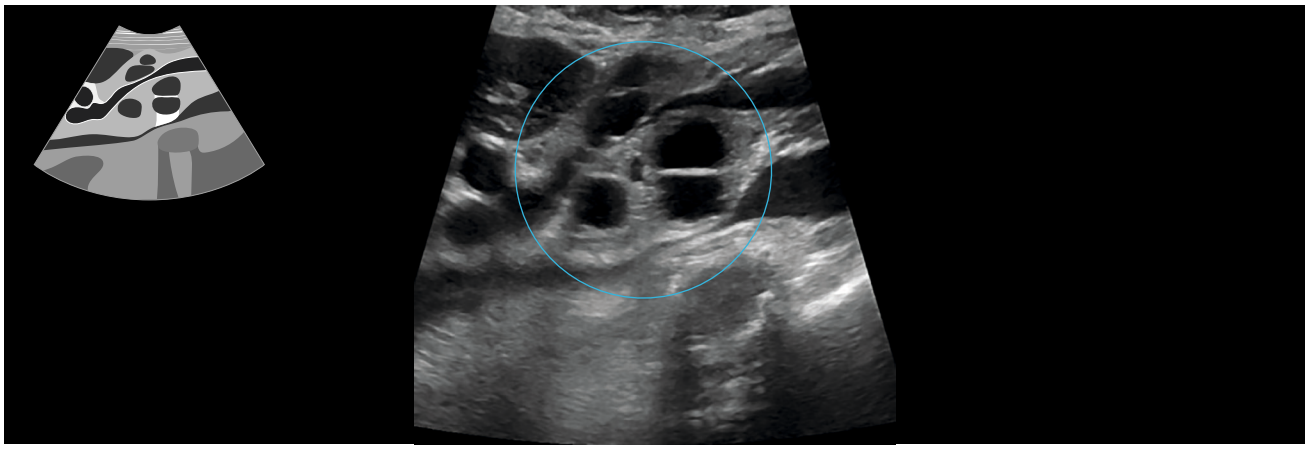
- Reminiscent of chronic pancreatitis
- Segmental or diffuse distribution
- Highest malignant potential
- ~ 60% are malignant

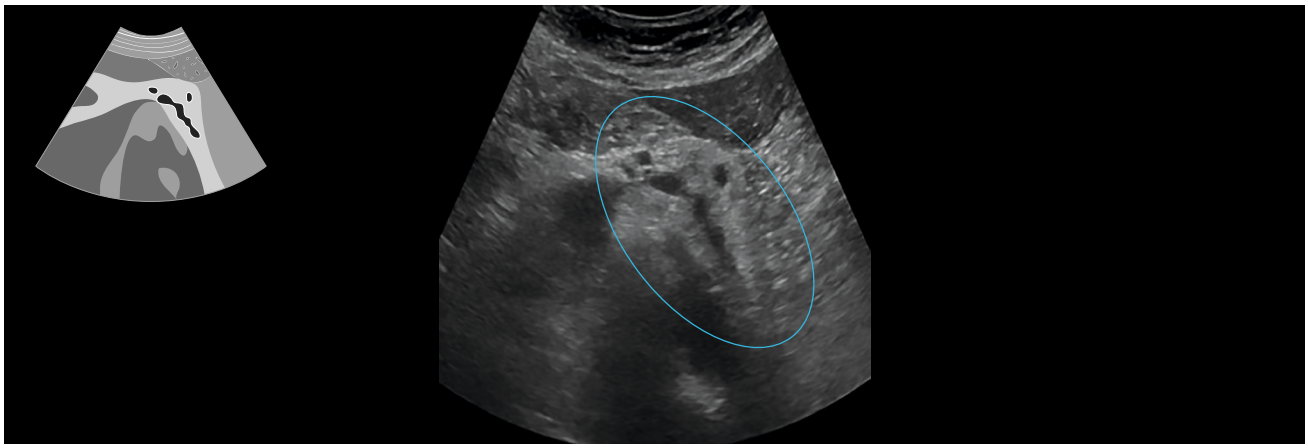
Branch duct tumors

- Mostly seen in the head and uncinate process
- More localized and mass-like
- May be multifocal
- May be macro or microcystic in appearance
- Indolent behaviour
- ~ 5% (range 2–10%) are malignant

Mixed type lesions

The presence of solid components as well as bile duct dilation are suspicious of malignant transformation.





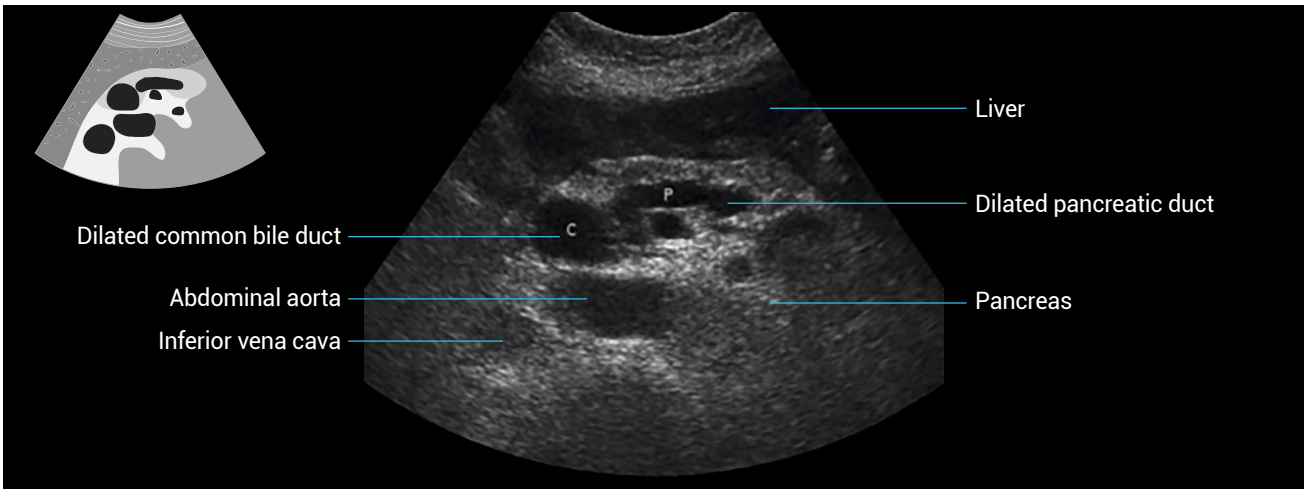
The Pancreas

IDENTIFIYING SOLID TUMORS OF THE PANCREAS

Double duct sign

The double duct sign represents the dilatation of the common bile and the pancreatic ducts due to occlusion by a pancreatic head tumor.

This can only occur if the tumor is in the pancreas head and obstructs both ducts.



Neuroendocrine tumor

Syndromic tumors tend to present earlier, with clinical signs and symptoms related to their cell type and biological activity.

- Insulinoma: Whipple's triad
- Gastrinoma: Zollinger-Ellison syndrome
- Glucagonoma: 4D syndrome
- Non-functioning tumors tend to present late, similar to pancreatic adenocarcinomas
- Non-syndromic tumors tend to present later and are often larger in size.

Neuroendocrine tumors can be divided according to whether or not they secrete enough active compounds to be syndromic or not.

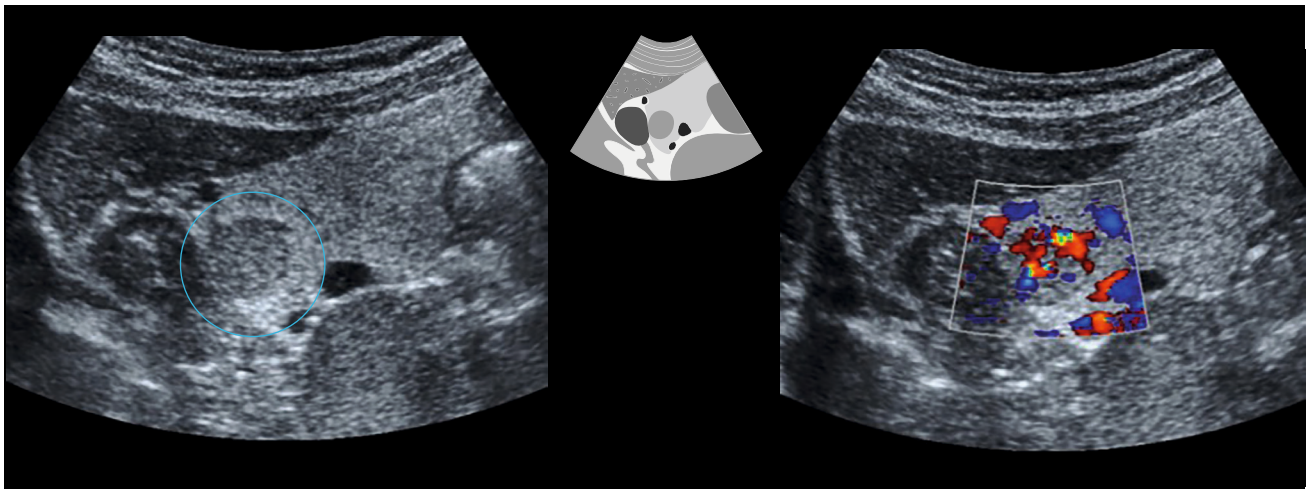
Syndromic tumors

- Insulinoma: most common
- Gastrinoma: second most common
- Glucagonoma
- VIPoma
- Somatostatinoma
  (some of these can be non-functional)

Non-syndromic tumors

Most common non-syndromic tumors are typically well circumscribed with smooth margins, round or oval shape, and can be hypoechoic.

Their liver metastases may be hyperechoic or targetoid.



Pancreatic ductal adenocarcinoma

Pancreatic ductal adenocarcinoma makes up the vast majority (~ 90%) of all pancreatic neoplasms and remains a disease with very poor prognosis and high morbidity.

Cancerous cells arise from the pancreatic ductal epithelium. Three precursor lesions for pancreatic adenocarcinoma have been identified.

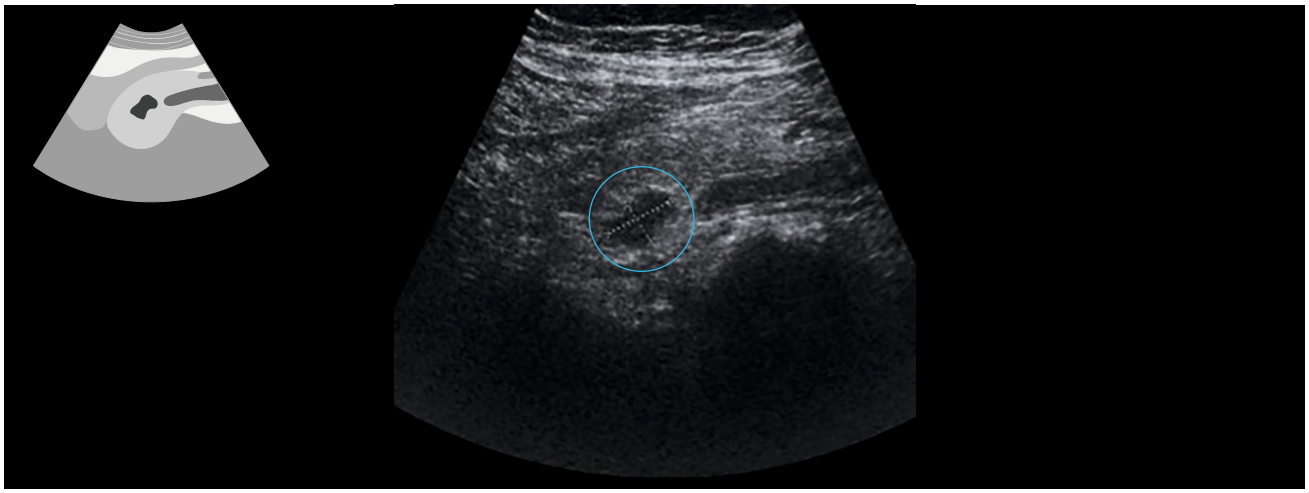
1. Pancreatic intraepithelial neoplasia
2. Intraductal papillary mucinous neoplasm
3. Mucinous cystic neoplasm

It is important to identify and accurately stage these tumors due to the fact that 90% are not resectable.

The key to accurate staging is the assessment of the superior mesenteric artery (SMA) and celiac axis, which if involved exclude the patient from any attempted resection. Typically a CT is used to definitively identify these tumors with imaging, however, a laparoscopy is often required to confirm resectability.

Since adenocarcinomas are solid tumors with a large connective tissue component, the vascularity of these tumors is low, making them hypoechogenic and poorly circumscribed.

Tumors located in the pancreatic head can cause occlusion of the common bile duct and the pancreatic duct resulting in the double duct sign.



Metastases

Although any primary tumor may eventually deposit in the pancreas, the most common metastases encountered include

- Renal cell carcinoma (most common)
- Melanoma
- Breast cancer
- Lung cancer
- Gastric cancer
- Colorectal carcinoma

Metastases appear as solid hypoechogenic masses located within the pancreatic parenchyma. Cysts are generally not a feature of metastatic pancreatic tumors.