Cystic Masses of the Pancreas[1]

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Although the pseudocyst is the most common cystic mass of the pancreas found at imaging studies, radiologists should be aware of the multiple disease processes that can manifest in a similar manner. This article reviews these other entities by category of the origin of the mass, including congenital, inflammatory, and neoplastic. Computed tomography, ultrasound, and magnetic resonance imaging studies are presented, and, although the considerable overlap of imaging features makes it generally impossible to render a specific diagnosis, combining the findings from these modalities is helpful in formulating a differential diagnosis. Because a cystic mass of the pancreas is not always a pseudocyst, percutaneous drainage should be followed by cytologic analysis of the aspirate. A biopsy of the wall of the cystic mass may also be necessary.

■ INTRODUCTION

Cystic lesions of the pancreas are detected relatively frequently with imaging studies in routine clinical practice. Although most cystic lesions of the pancreas are pseudocysts arising as a consequence of pancreatitis, the radiologist should be aware that an ample gamut of pathologic entities can produce the imaging appearance of a cystic mass in the pancreas.

This article presents a classification of cystic masses in the pancreas (Table) and a review of the findings at imaging.

Index terms: Pancreas, CT, 77.1211 • Pancreas, cysts, 77.312 • Pancreas, MR, 77.1214 • Pancreas, neoplasms, 77.31, 77.32 • Pancreas, US, 77.1298

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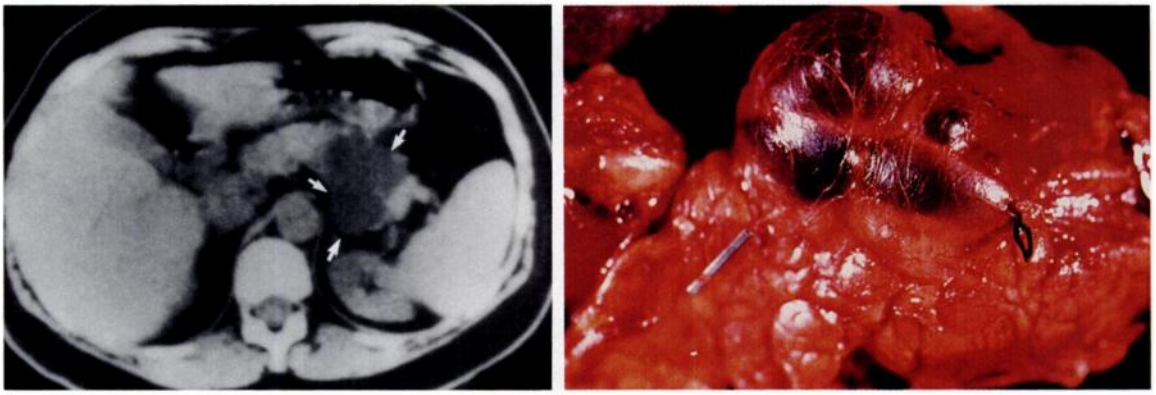


a. b.

Figure 1. Single true cyst of the pancreas in a 56-year-old woman. **(a)** CT scan shows a cystic mass of attenuation equal to that of water. The mass does not appear enhanced with administration of contrast material (arrows). **(b)** Photograph shows resected tail of the pancreas containing a true cyst. Histologic examination of the wall demonstrated the presence of epithelial lining and helped confirm the diagnosis of a true cyst.

■ CONGENITAL CYSTIC MASSES

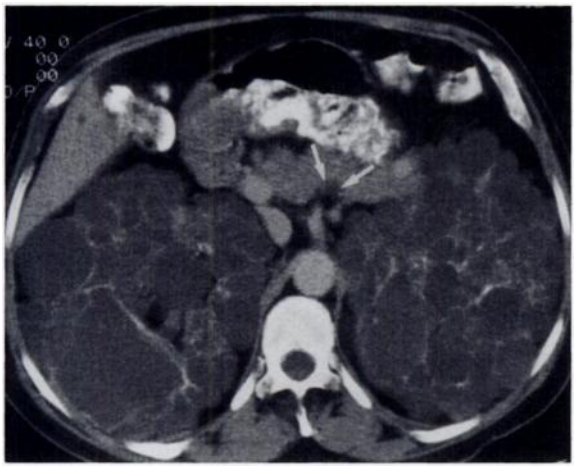
• Single True Cyst

A true cyst of the pancreas is derived from an abnormal segmentation of the primitive ducts of the pancreas and has a true epithelium lining its inner surface (1). Isolated congenital true cysts are extremely rare; most are seen in newborns, although a few have been reported in adults (1–3).

True pancreatic cysts may be unilocular or multilocular and usually range in size from microscopic to 5 cm (1). Ultrasound (US) and computed tomography (CT) demonstrate an anechoic, low-attenuating mass with an attenuation coefficient of 0–20 HU, which is typical of any simple cyst. No enhancement is seen after intravenous administration of contrast material (Fig 1).

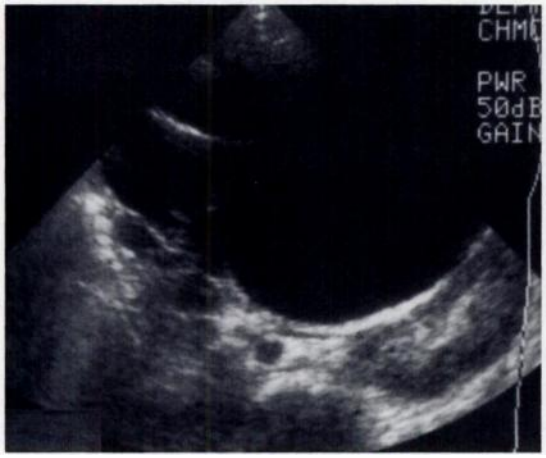
Classification of Cystic Masses of the Pancreas

- Congenital cystic masses
  - Single true cyst
  - Multiple true cysts
    - In adult polycystic kidney disease
    - In von Hippel-Lindau disease
    - In cystic fibrosis
- Inflammatory cystic masses
  - Pseudocyst
  - Abscess
  - Echinococcus cyst
- Neoplastic cystic masses
  - Benign neoplasms
    - Microcystic adenoma
    - Cystic teratoma
  - Malignant or potentially malignant neoplasms
    - Islet cell carcinoma
    - Mucinous cystic neoplasms
    - Solid and papillary epithelial neoplasms
    - Lymphoma
    - Anaplastic carcinoma



2.

Figures 2, 3. **(2)** Typical presentation of adult polycystic kidney disease. CT scan demonstrates massive involvement of the kidneys and mild involvement of the liver. In the pancreas, only a very small cyst (arrows) is identified. **(3)** Atypical presentation of adult polycystic kidney disease. **(a)** US image demonstrates multiple large cysts in the pancreas in a 2-month-old male infant. **(b)** CT scan also shows predominant involvement of the pancreas, with only a few cysts in the kidneys and liver.



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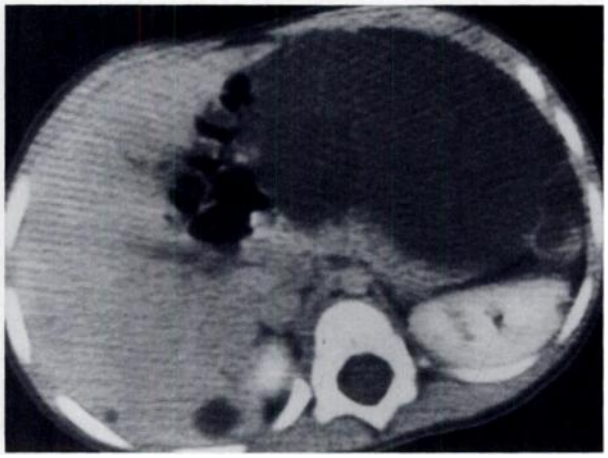


3b.

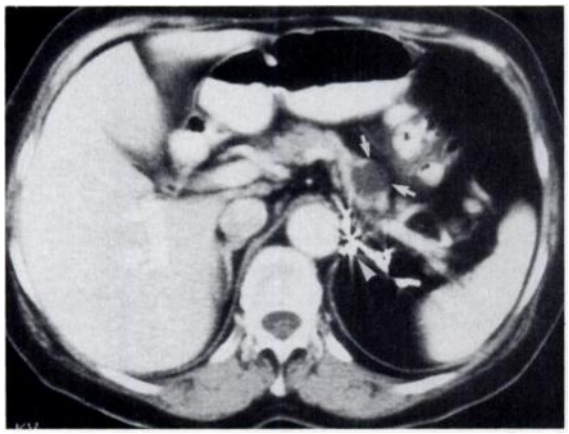
• Multiple True Cysts

Most congenital cysts of the pancreas are multiple and are associated with genetic disorders that involve cystic disease in other organs, including adult polycystic kidney disease, von Hippel-Lindau disease, and cystic fibrosis; these cysts may also occur as solitary lesions.

Multiple true cysts of the pancreas are seen in approximately 10% of patients with adult polycystic kidney disease (4). These cysts are usually small and may either diffusely involve the pancreas or localize to one region. The number of cysts varies, but, typically, pancreatic involvement is less than the cystic change seen in the kidneys and liver (Fig 2). Rarely, pancreatic involvement may predominate (Fig 3).

CT and US findings of the individual cystic lesions are similar to those for single true cysts. Concomitant hepatic and renal involvement facilitates diagnosis when cysts also are seen in the pancreas.

In von Hippel-Lindau disease, cysts are seen in the kidneys, adrenal glands, liver, and spleen, in addition to the pancreas (5,6). Renal cell carcinoma and microcystic adenoma of the pancreas are also associated with this disease (6). In this autosomal dominant disorder, pancreatic cysts are demonstrated in approximately 30% of patients who undergo



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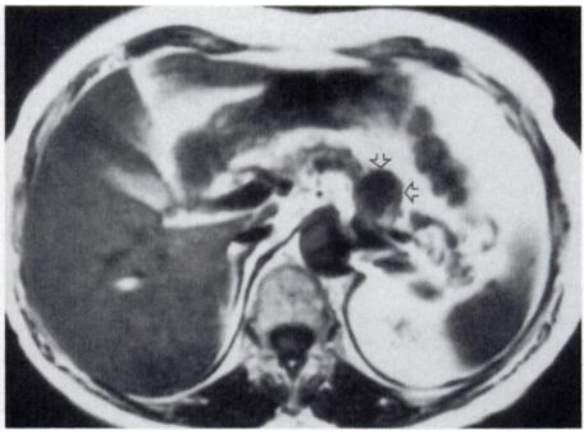

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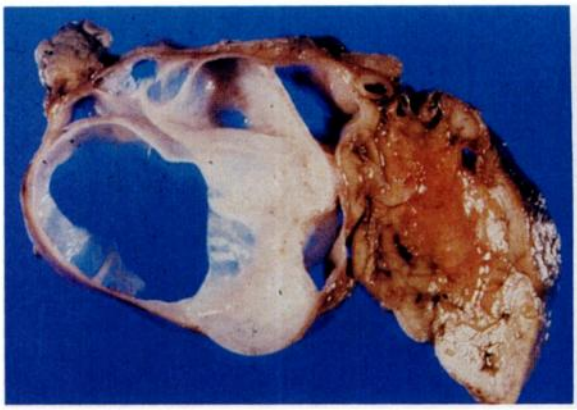

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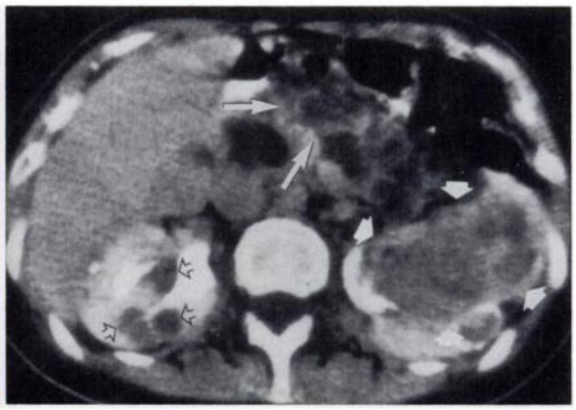


5.

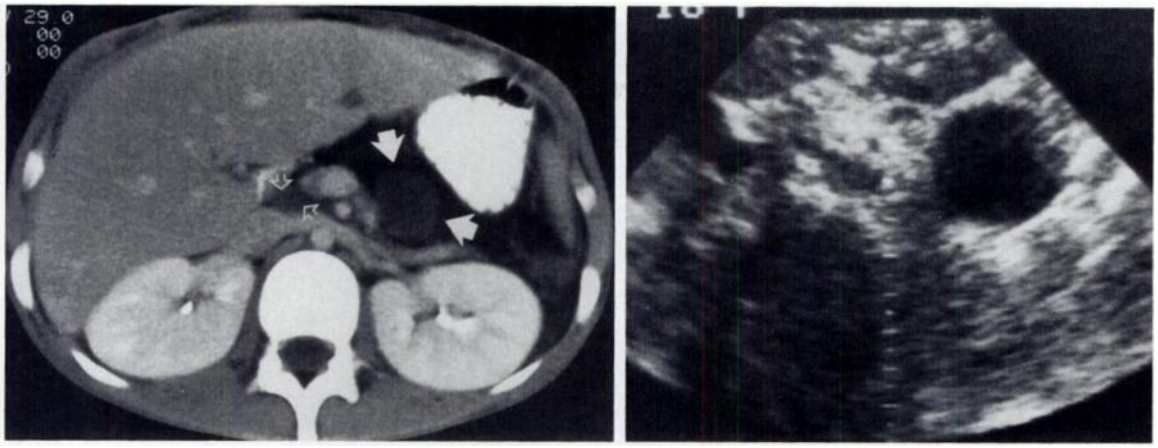
Figures 4, 5. **(4)** von Hippel-Lindau disease in a 66-year-old woman. **(a)** CT scan shows a cyst (arrows) in the tail of the pancreas. Note the surgical clips from a previous left adrenalectomy for pheochromocytoma (arrowhead). **(b)** T1-weighted MR image (repetition time, 300 msec; echo time, 20 msec [300/20]) shows the cyst as a focal area of low signal intensity (arrows). **(c)** Photograph of a cut section of the cyst attached to the tail of the pancreas demonstrates thin walls and several loculi. **(5)** CT scan demonstrates extensive involvement of the pancreas by multiple cysts in von Hippel-Lindau disease (long solid arrows), which led to diabetes. There is also a renal cell carcinoma in the left kidney (short solid arrows) and multiple cysts in the right kidney (open arrows).

imaging studies, but data obtained at autopsy indicate that true cysts are found in the pancreas in a greater proportion of cases (5).

Imaging studies demonstrate cysts in the pancreas and other abdominal organs (Figs 4, 5). Not infrequently, these cysts show foci of calcification in the periphery on CT scans, which are seen as acoustic shadowing on US images (6).

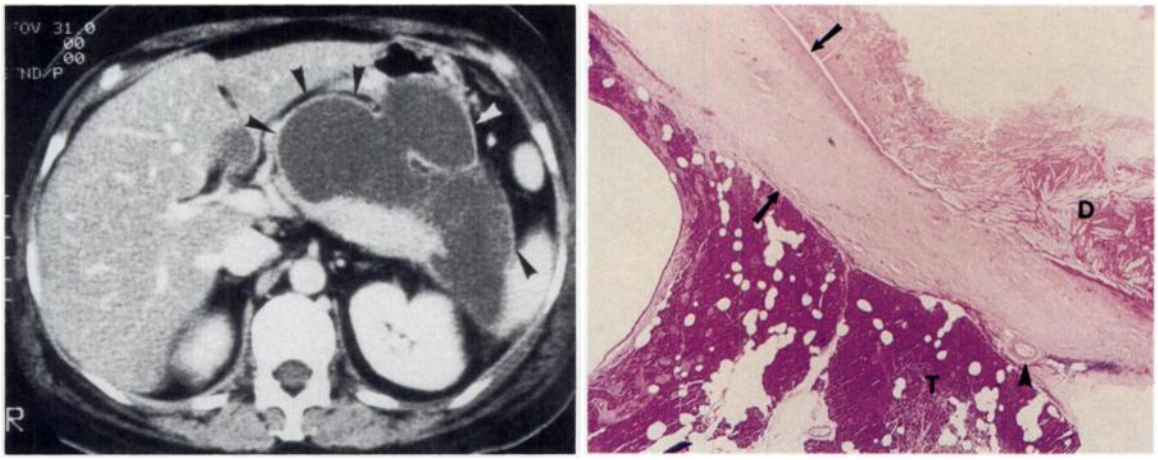
Progressive dilatation of the acini and pancreatic ducts with secondary fibrosis and resultant pancreatic atrophy is seen in cystic fibrosis. Eventually, there is fatty replacement of the pancreatic parenchyma (7,8). Rarely, macroscopic true cysts, which represent dilated remnants of the pancreatic ducts, are seen, usually in chronic disease (7).

CT scans show cysts as low-attenuation (0–25 HU) lesions surrounded by pancreatic parenchyma in a range relative to that of typical fat (−90 to −120 HU) (Fig 6). US shows findings typical for a simple cyst. The fatty-replaced surrounding parenchyma appears echogenic (8).



a. b.

Figure 6. Cystic fibrosis in an 11-year-old girl. **(a)** CT scan demonstrates a cystic mass in the tail of the pancreas (solid arrows). Note fatty replacement of the pancreatic parenchyma, shown as an area of low attenuation (open arrows). **(b)** US image helps confirm the cystic nature of the mass seen with CT.



a. b.

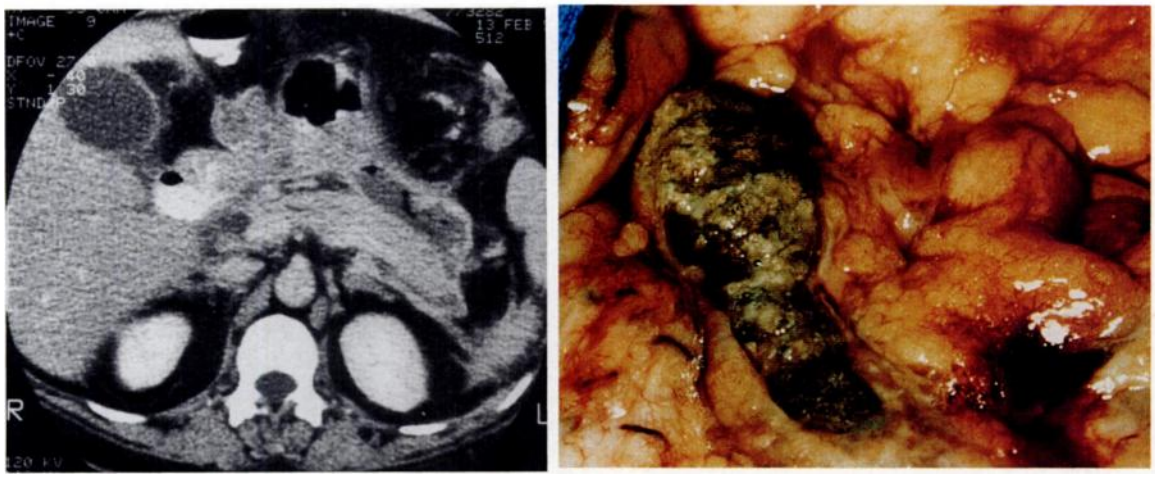
Figure 7. Pancreatic pseudocyst. **(a)** CT scan demonstrates a pseudocyst anterior to the tail of the pancreas. Note the enhancement of the fibrous wall (arrowheads) of the pseudocyst. **(b)** Low-power photomicrograph (original magnification, ×40; hematoxylin-eosin stain) shows the fibrous wall of a pseudocyst (arrows) anterior to the tail of the pancreas (*T*). Note the presence of debris (*D*) in the lumen of the pseudocyst, indicating a previous hemorrhage. A vessel (arrowhead) is noted in the fibrous wall.

■ INFLAMMATORY CYSTIC MASSES

• Pseudocyst

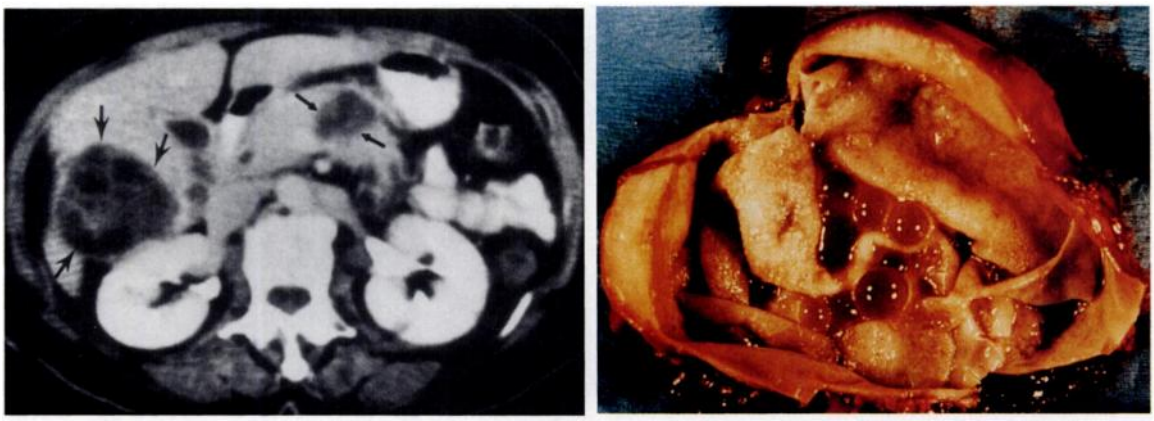
The most common cystic mass of the pancreas is a pseudocyst, which is seen as a complication of acute pancreatitis in approximately 2%–3% of all cases (9). These cystic structures are characterized microscopically by a fibrous wall, which develops over a period of approximately 6 weeks (Fig 7) (10). These cystic structures do not have an epithelial lining and are thus pseudocysts (1). The fibrous wall surrounds a collection of pancreatic fluids, cellular debris, and blood (11).

On US images, pseudocysts are usually well-defined, smooth-walled, anechoic masses, although they may occasionally be multilocular with internal septations. Internal echoes or a fluid-fluid level may be seen with hemorrhage or infection. On CT scans, an uncomplicated pseudocyst should appear as a well-defined wall or capsule, with a central area of low attenuation and an attenuation coefficient within a range relative to that of water



a. b.

Figure 8. Pancreatic abscess. **(a)** CT scan demonstrates a low-attenuation cyst anterior to the tail of the pancreas, which contains multiple gas bubbles. The presence of gas bubbles is the most helpful imaging characteristic of pancreatic abscess. **(b)** Photograph of a surgical specimen shows greenish purulent fluid replacing pancreatic parenchyma.



a. b.

Figure 9. Hydatid disease of the liver and pancreas. **(a)** CT scan shows a multilocular cyst in the right lobe of the liver (large arrows) and a second, smaller multilocular cyst in the body of the pancreas (small arrows). **(b)** Photograph of a specimen from a liver echinococcus cyst demonstrates the complex internal nature of the cyst, with daughter cysts and hydatid sand.

(Fig 7). Magnetic resonance (MR) imaging may be helpful to detect hemorrhage or associated splenic vein thrombosis.

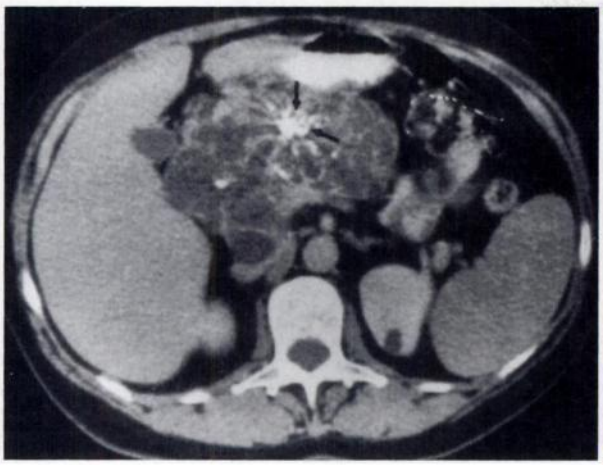
• Abscess

A more severe sequela of pancreatitis is the pancreatic abscess. Infection follows acute pancreatitis with variable frequency; some studies cite percentages of 1%–21% of cases (10,11). Some authors (12) have reported that abscess is seen more frequently in cases of pancreatitis that result from biliary tract obstruction or peptic ulcer disease than is seen in cases of alcoholism.

Radiologically, in contrast to a pseudocyst, which usually has a distinct wall or capsule, a pancreatic abscess generally has indistinct margins (Fig 8) (11). The most helpful diagnostic finding is gas bubbles, which are demonstrated in 13%–22% of cases (11,13).

• Echinococcus Cyst

Hydatid disease of the pancreas is a rare cause of a cystic pancreatic mass. Because the parasite must traverse the hepatic and pulmonary filters, liver involvement (75% of cases) and lung involvement (15% of cases) are more common than pancreatic involvement, with only five cases described in the literature (14,15).



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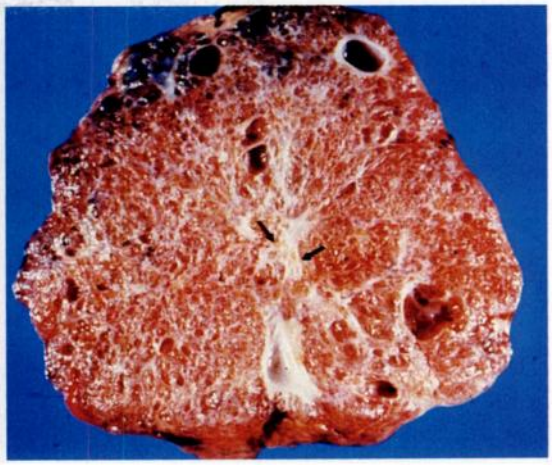

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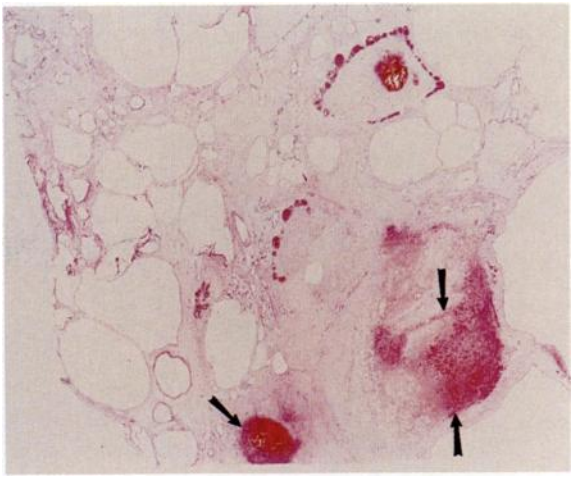


c.

Figure 10. Microcystic adenoma. **(a)** CT scan shows a large pancreatic mass with hyperattenuating, enhanced septations and multiple small cystic spaces. Large calcifications are seen in the center of the tumor (arrows). **(b)** Photograph of cut surface demonstrates the honeycomb appearance typical of microcystic adenomas with multiple small cysts. Note central fibrous scar (arrows). **(c)** Photomicrograph (original magnification, ×40; hematoxylin-eosin stain) shows areas of hemorrhage (arrows), which are frequently present in this well-vascularized tumor. Cells lining the cystic spaces have no malignant potential.

US scans may demonstrate a spherical, anechoic mass if the lesion is unilocular, an appearance that is indistinguishable from that of a pseudocyst or a true cyst. More commonly, CT and US scans may show multiple septations, corresponding to daughter cysts. Intravenous administration of contrast material may result in enhancement of the pericystic region (Fig 9). Also, calcification may be seen surrounding the cystic mass (14,15).

■ NEOPLASTIC CYSTIC MASSES

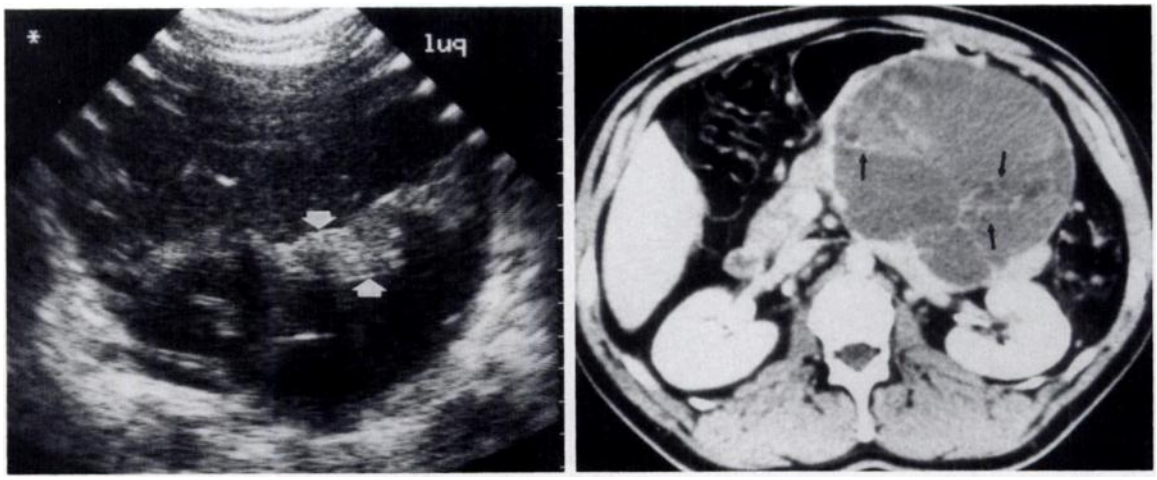
Cystic neoplasms of the pancreas (microcystic adenoma and mucinous cystic neoplasms) or pancreatic tumors that show cystic change (islet cell tumors, solid and papillary epithelial neoplasms, anaplastic carcinoma, and cystic teratoma) are uncommon, representing only 10%–15% of all pancreatic neoplasms and less than 5% of all malignant pancreatic tumors (16–18).

• Benign Neoplasms

Microcystic adenoma is a glycogen-containing hypervascular tumor with no malignant potential (16–19). This tumor is more common in female patients, with cited ratios of 1.5–4.5:1 (19,20). In published series (20,21), the median age of these patients is typically in the 7th or 8th decade (20,21), with Friedman et al (19) noting that approximately 80% of patients were 60 years of age or older. This tumor is associated with von Hippel-Lindau disease (21).

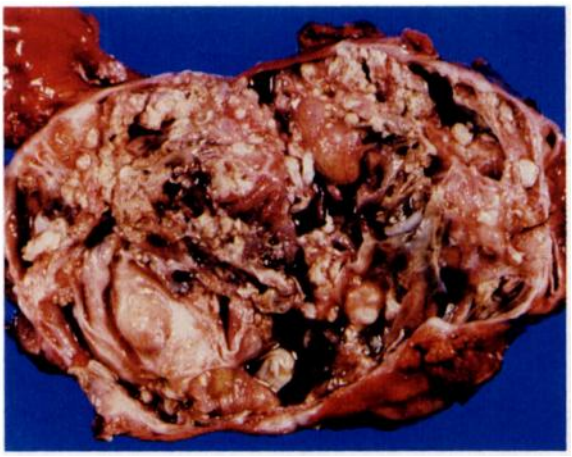
Microscopically, areas of hemorrhage are often associated with this tumor (Fig 10), since it is a hypervascular neoplasm. It is classified as a cystic neoplasm of the pancreas, primarily because of its microscopic appearance.

At gross pathologic examination, a microcystic adenoma may appear primarily as a solid tumor with multiple small cystic areas that are usually less than 2 cm in size (Fig 10).



a. b.

Figure 11. Teratoma of the pancreas. **(a)** US image of the left upper quadrant shows a large multicystic mass. Note the solid component (arrows). **(b)** CT scan demonstrates a predominantly cystic mass with thick walls and septations. Areas of fatty attenuation are also seen (arrows). **(c)** Photograph of cut section shows the complex nature of a pancreatic teratoma with multiple septations, thick wall, and areas of fat.



c.

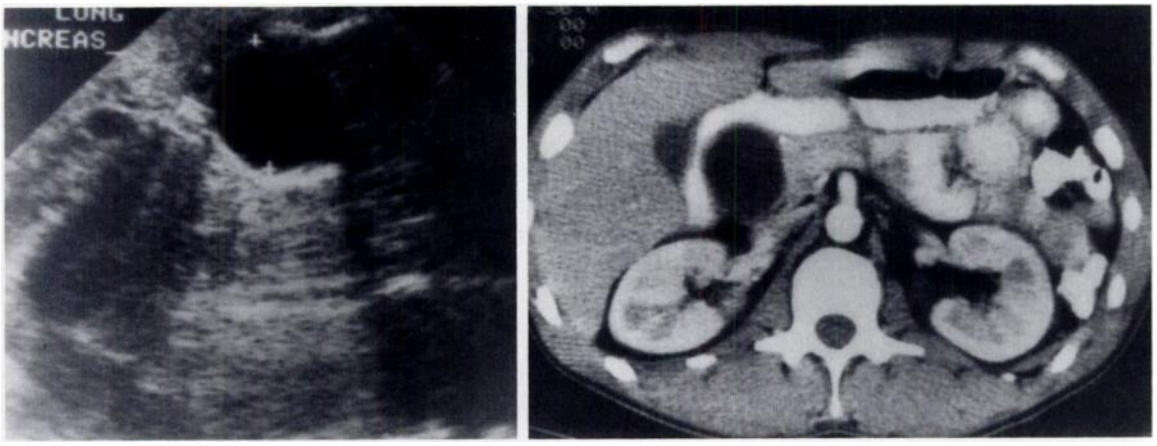
In up to 20% of cases, these tumors contain a central scar, which may calcify (19,21).

Imaging studies may show this tumor as either homogeneously solid, or, more commonly, they may demonstrate a predominantly solid mass with multiple small cysts. Some authors (21) have stated that the presence of six or more small cysts within the mass is suggestive of microcystic adenoma rather than mucinous cystic neoplasm.

Both CT and US scans show the solid and cystic components of this tumor. CT scans also demonstrate a calcified central scar, if present (Fig 11). Both CT and MR images show the well-delineated contour of these tumors, which are usually markedly hyperintense on T2-weighted MR images, although some central areas of low signal intensity may occasionally be seen related to scar formation. T1-weighted MR images show the tumor to be of low signal intensity, except in cases in which the tumor has hemorrhaged. In these cases, the areas of hemorrhage appear hyperintense on T1-weighted MR images (22).

A cystic teratoma is a slow-growing tumor that rarely involves the pancreas; only 10 cases have been reported (23). Most of the described cases have had cystic and solid components, such as hair, fat, and calcification (Fig 11) (23).

Both US and CT scans demonstrate the predominantly cystic characteristics of this tumor, as well as solid components and debris (Fig 11). CT may be helpful in showing the presence of fat or calcifications.



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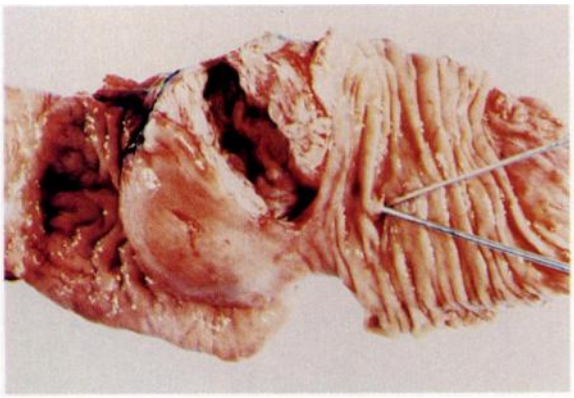


c.

Figure 12. Cystic insulinoma (islet cell carcinoma) in a 34-year-old man. **(a)** US image demonstrates a cystic mass, with acoustic enhancement and without evidence of debris, in the head of the pancreas. **(b)** CT scan shows a cystic mass that displaces the duodenum laterally. **(c)** Photograph of a specimen demonstrates the cystic nature of this mass and its intimate attachment to the duodenum. A metallic stent has been placed in the ampulla, indicating its relation to the mass.

• Malignant or Potentially Malignant Neoplasms

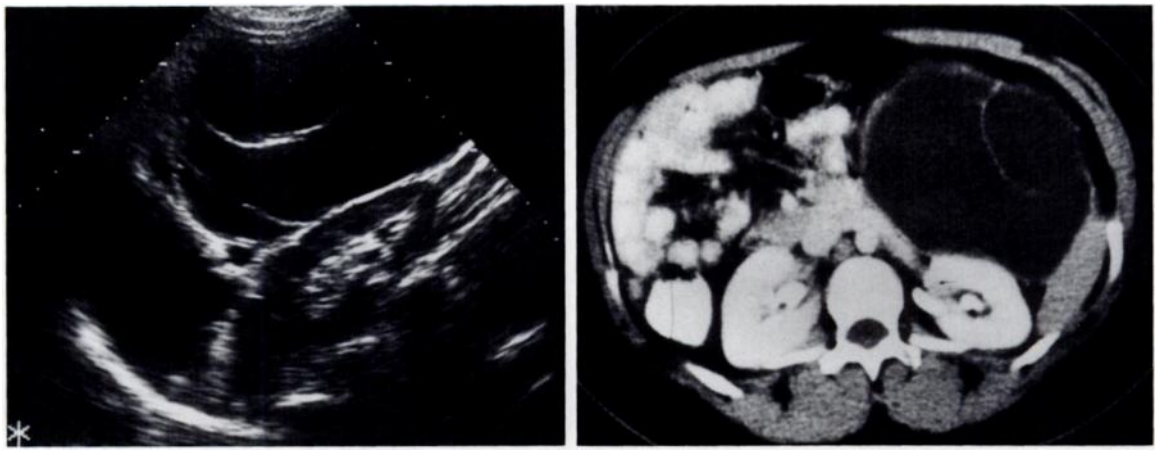
An islet cell carcinoma usually has a very good blood supply, is generally solid, and rarely has cystic or degenerative components. However, occasionally, a cystic form corresponding to necrosis may be seen in both functioning and nonfunctioning tumors (24–26). These neoplasms occur equally in men and women, are all locally invasive, and have malignant potential (1,25). Tumor behavior cannot always be predicted on the basis of histologic appearance (1).

CT, US, and MR images demonstrate a nonspecific cystic mass that often has a thick wall (Fig 12).

Because it is difficult to distinguish between a mucinous cystadenoma and a cystadenocarcinoma and because all mucinous tumors should be regarded as at least potentially malignant (19), they are now referred to as mucinous cystic neoplasms.

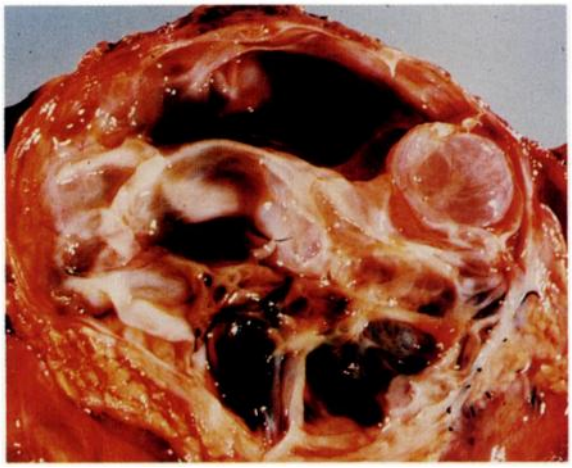
These tumors show a marked female predominance, with multiple studies (16,19,21) reporting occurrence in female patients in greater than 80% of cases. The typical age at diagnosis is the 6th decade, contrasting with the older patient seen with microcystic adenomas (19,21).

Approximately 70%–95% of these neoplasms are in the tail or body of the pancreas (16,18,19,21). Most frequently, these hy-



a. b.

Figure 13. Mucinous cystic neoplasm in a 56-year-old woman. **(a)** US scan demonstrates a large cystic mass containing septations in the tail of the pancreas. **(b)** Contrast-enhanced CT scan reveals a mass with an attenuation coefficient in the range of that of water, with an internal septation and mild nodularity of its wall. **(c)** Photograph of cut section shows the macrocystic nature of these tumors with large cystic spaces and multiple septations.

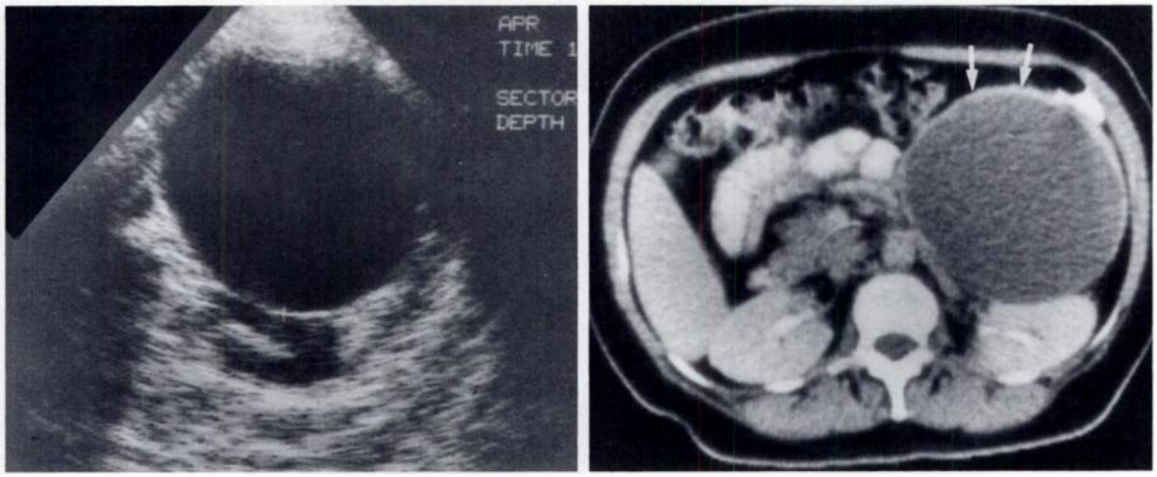


c.

povascular tumors are multilocular, but they may be unilocular. They contain mucin and usually have a thick wall, internal septations, solid papillary excretions, and, occasionally, peripheral calcifications (Figs 13–15) (19).

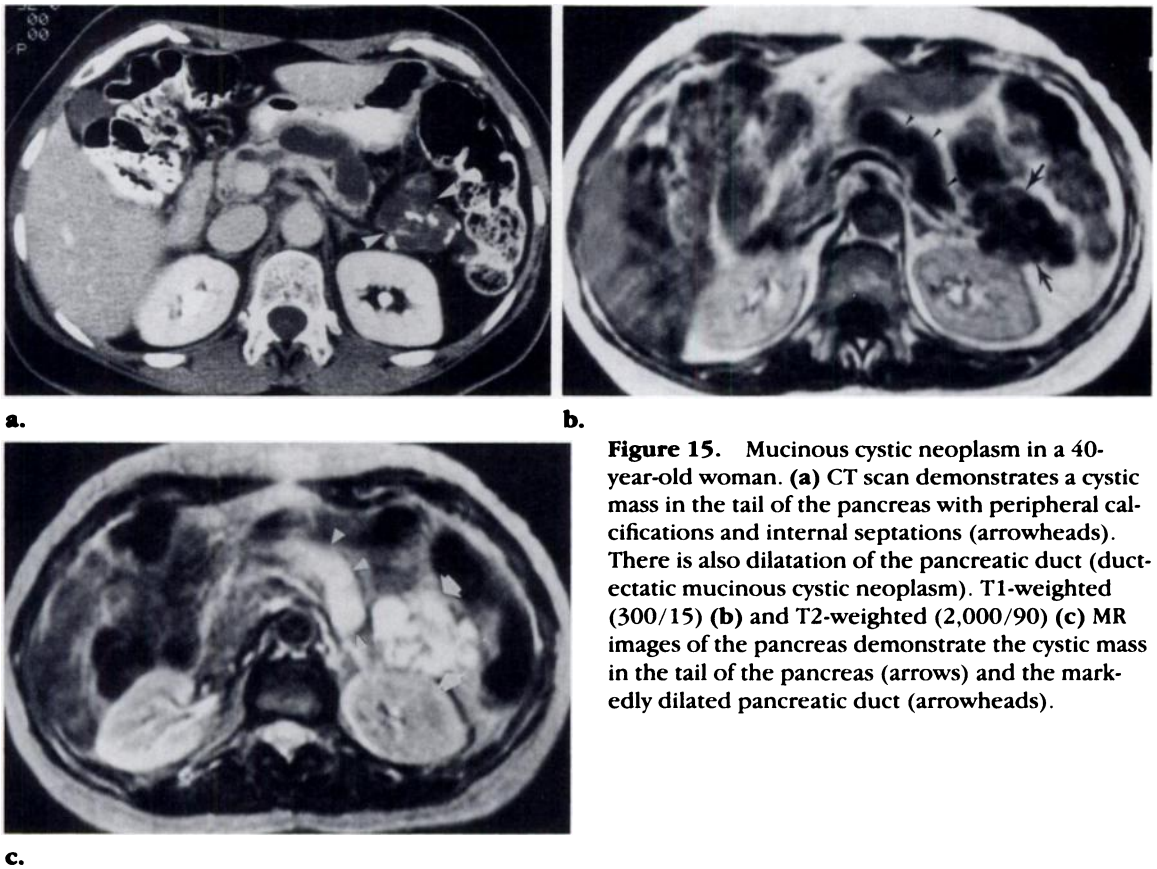
CT and US imaging studies show the unilocular or multilocular nature of this mass. If a mucinous cystic neoplasm is unilocular without septations identifiable with imaging studies, its differentiation from a pseudocyst may not be possible. US is advantageous to show internal septations, mural nodules, and solid excrescences in the tumor wall (Figs 13, 14).

CT scans obtained after the intravenous administration of contrast material may demonstrate enhancement of the septations and peripheral wall (Figs 13–15) (19). MR images show the contents of these cystic masses to be variable in signal intensity, and this variability is thought to be related to hemorrhage or the proteinaceous nature of the fluid (Fig 15b, 15c) (22).



a. b.

Figure 14. Mucinous cystic neoplasm in a 66-year-old woman. **(a)** US image demonstrates an anechoic mass in the tail of the pancreas. **(b)** CT scan also shows the unilocular cystic mass. Except for a mildly irregular wall (arrows), this mass was indistinguishable from a pseudocyst and was treated initially with percutaneous drainage. At surgery, the mass proved to be a mucinous cystic tumor.



a. b. c.

Figure 15. Mucinous cystic neoplasm in a 40-year-old woman. **(a)** CT scan demonstrates a cystic mass in the tail of the pancreas with peripheral calcifications and internal septations (arrowheads). There is also dilatation of the pancreatic duct (ductectatic mucinous cystic neoplasm). T1-weighted (300/15) **(b)** and T2-weighted (2,000/90) **(c)** MR images of the pancreas demonstrate the cystic mass in the tail of the pancreas (arrows) and the markedly dilated pancreatic duct (arrowheads).

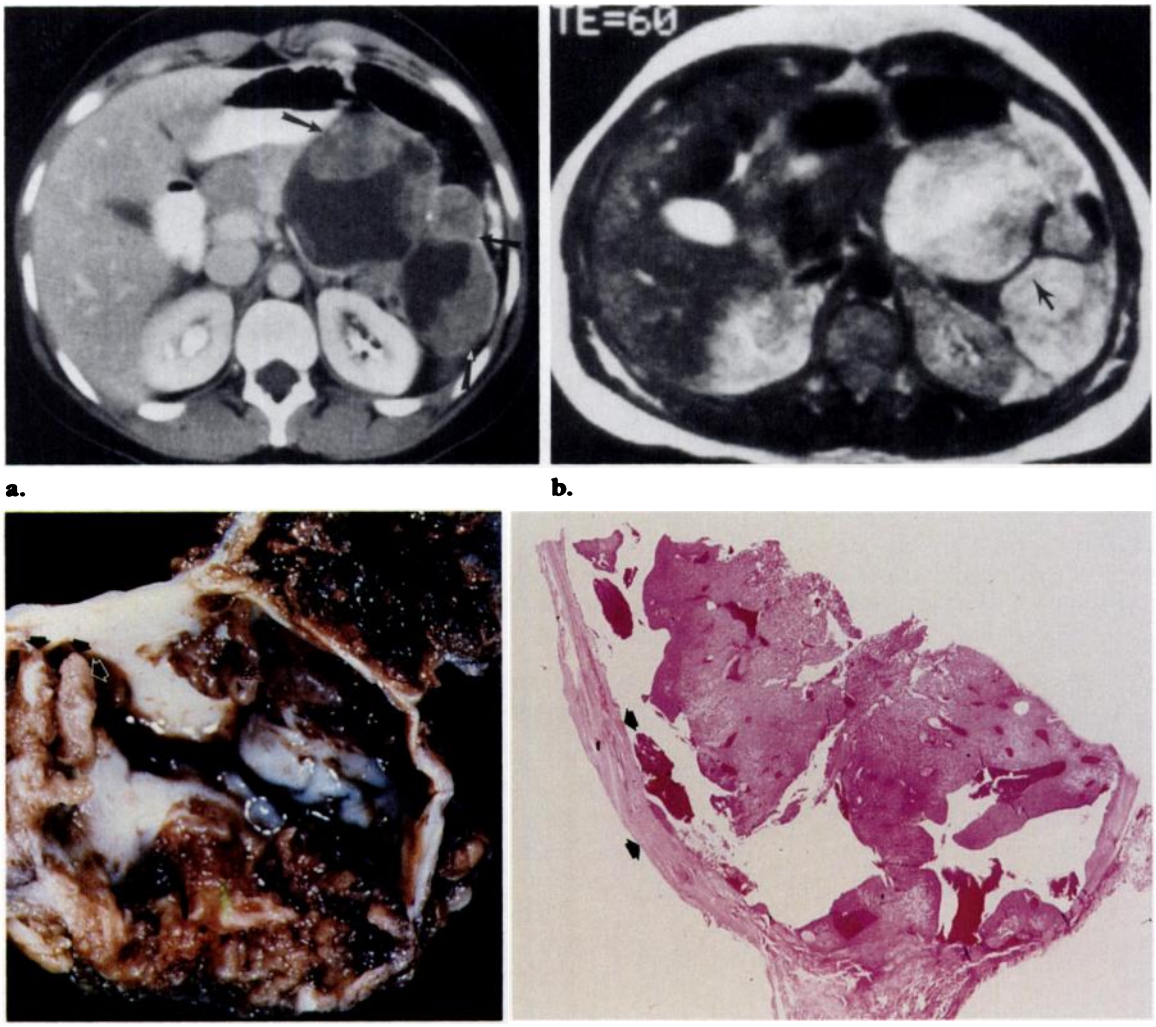


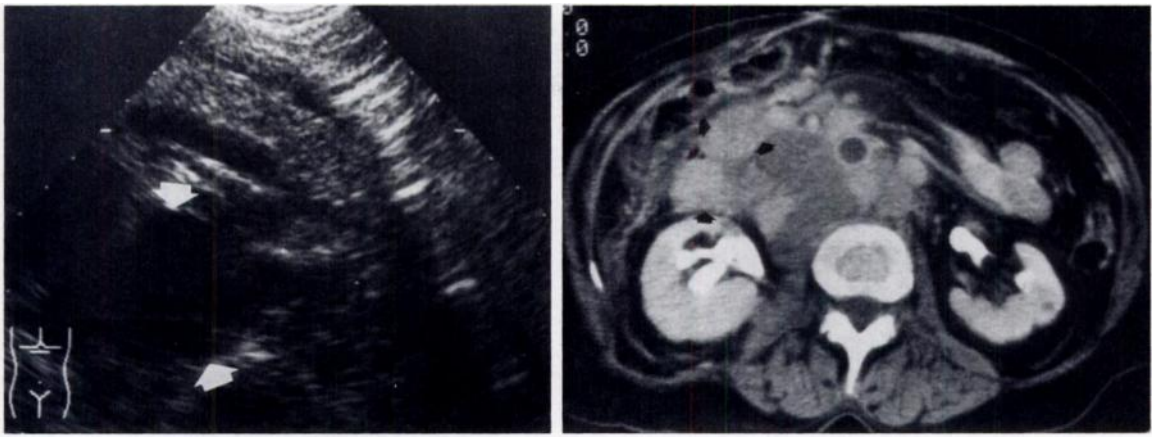
Figure 16. Solid and papillary epithelial neoplasm. **(a)** CT scan shows the solid (arrows) and cystic nature of this tumor. **(b)** T2-weighted MR image shows the capsule as a hypointense peripheral rim (arrow), as well as solid and cystic components of the mass. **(c)** Photograph of a cut-section specimen shows a whitish, fibrous capsule and papillary excrescences (arrows). **(d)** Photomicrograph (original magnification, ×40; hematoxylin-eosin stain) demonstrates a thick fibrous capsule typical of this tumor (arrows). Both solid and cystic components are also seen. Areas of hemorrhage are frequently noted in this tumor.

Solid and papillary epithelial neoplasms are rare tumors, more commonly seen in young women; they are considered to be low-grade malignancies (27). A thick capsule is usually present, and internal components are complex (although, occasionally, purely cystic or solid tumors are seen) (Fig 16). Internal septations are not a feature of this tumor. Calcification is uncommon but may be seen in the tumor or its capsule (28).

CT, US, and MR images show the internal inhomogeneity (cystic and solid) of this large mass. These tumors are well delineated because of their thick capsule, which is seen as a hypointense rim on T2-weighted MR images (Fig 16). CT and MR images may be helpful in demonstrating the presence of hemorrhage.

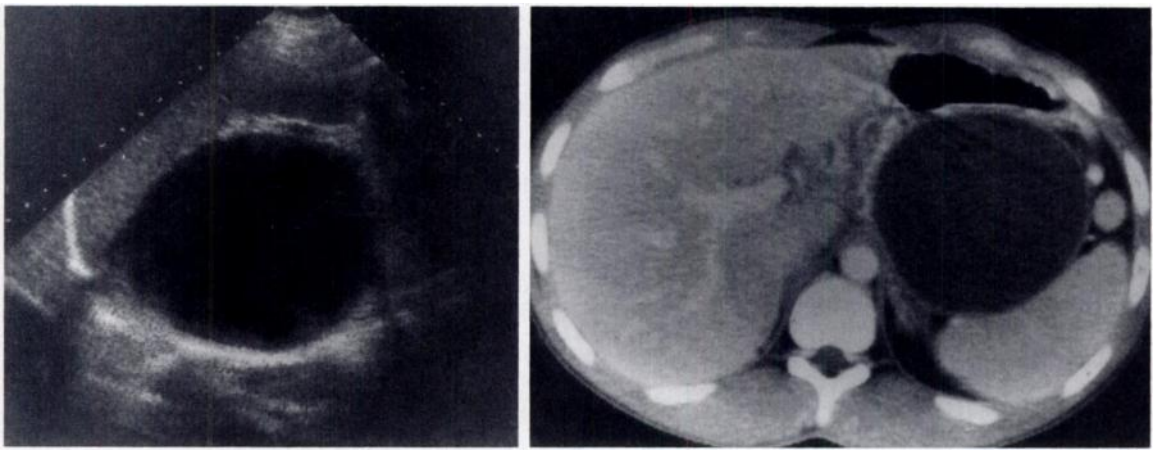
Primary lymphoma of the pancreas is extremely rare, although involvement in the region of the pancreas is not uncommonly seen as a result of massive retroperitoneal adenopathy (29). This tumor may appear homogeneously hypoechoic on US images, mimicking a cystic appearance (Fig 17). Also, because of internal necrosis, a lymphoma may have cystic components.

Anaplastic carcinoma refers to aggressive, undifferentiated neoplasms and includes giant cell and spindle cell carcinoma of the pancreas or retroperitoneum (30). These tumors



a. b.

Figure 17. Lymphoma in a 68-year-old woman. **(a)** US image obtained in the region of the pancreatic head shows a hypoechoic lesion (arrows) similar to a cystic mass. **(b)** CT scan obtained later shows the solid nature of the mass (arrows).



a. b.

Figure 18. Undifferentiated pancreatic carcinoma in a 19-year-old man. **(a)** US image demonstrates a predominantly cystic, unilocular mass in the tail of the pancreas. A small amount of debris is seen within the cystic mass. **(b)** CT scan demonstrates a large cystic mass with a thin capsule. The almost totally cystic nature of these very aggressive tumors is secondary to massive internal necrosis and hemorrhage.

are usually large and have cystic components secondary to massive internal necrosis and hemorrhage.

US and CT scans demonstrate a predominantly cystic mass, frequently containing internal echoes and debris (Fig 18).

■ CONCLUSION

Although the postinflammatory pseudocyst is overwhelmingly the most common cystic pancreatic mass to be imaged, the radiologist should be aware of the multiple entities, variable prognosis, and clinical significance involved when a cystic mass in the pancreas is encountered. It is especially important to consider these less common entities in patients with genetic syndromes associated with cystic pancreatic disease, findings atypical for pancreatic pseudocyst, and pseudocysts refractory to therapy.

In the majority of cases, it is not possible to provide a specific diagnosis because of the substantial overlap of imaging features. However, in the appropriate clinical setting, a reasonable differential diagnosis can be formulated by combining the findings of CT, US, and MR imaging.

In general, pseudocysts are unilocular cystic masses that have a thick enhanced wall and no gas bubbles. Mucinous cystic neoplasms, as well as anaplastic carcinoma and cystic islet cell tumors, may occasionally have a similar appearance. Considerations for multilocular cysts include mucinous cystic neoplasms, microcystic adenoma, echinococcus cysts, and, occasionally, postinflammatory pseudocysts.

The presence of fat in a cystic mass supports the diagnosis of teratoma, and gas bubbles are suggestive of abscess. Most true cysts of the pancreas are associated with diseases in which cysts in other organs are seen, although a single true cyst may occasionally be noted. It is important to emphasize that a "cystic" mass of the pancreas is not always a pseudocyst, and, therefore, percutaneous drainage should be followed by appropriate cytologic analysis of the aspirated fluid; a biopsy of the wall of the cystic mass may also be necessary.

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