

Cystic tumors of the pancreas: a radiological perspective

Murat Acar, Servet Tatlı

ABSTRACT

The purpose of this article is to highlight the imaging features of cystic pancreatic tumors. Common cystic pancreatic tumors include serous microcystic adenomas, mucinous cystic tumors, intraductal papillary mucinous neoplasms and solid pseudopapillary tumors. These tumors have characteristic imaging features, especially on magnetic resonance imaging (MRI) and MR cholangiopancreatography examinations. Imaging findings allow a reasonable differential diagnosis between benign and malignant cystic pancreatic tumors. Thus, accurate imaging characterization of these lesions may lead to accurate patient care and prevent unnecessary surgical interventions.

Key words: • tomography, x-ray computed • magnetic resonance imaging • pancreatic neoplasms

The most common cystic pancreatic lesions are pancreatitis-related pseudocysts. However, when a diagnosis of pancreatitis is excluded, cystic tumors must be considered. Cystic pancreatic tumors are relatively rare, representing approximately 10% of all pancreatic neoplasms; 1% of these cystic tumors are malignant (1, 2). Most cystic pancreatic tumors are detected incidentally as a result of the increased use of cross-sectional imaging. Because of the improved spatial resolution of computed tomography (CT), small cystic lesions are being detected with increasing frequency. Although different pathologic types of cystic pancreatic tumors have been reported, serous microcystic adenomas, mucinous cystic tumors (MCTs), intraductal papillary mucinous neoplasms (IPMNs) and solid pseudopapillary tumors (SPTs) account for 90% of all primary cystic pancreatic tumors (3). Schematic illustrations of the typical appearances of four of the most common pancreatic cystic tumors are shown in Fig. 1.

Uncommon cystic pancreatic tumors include cystic metastases, cystic endocrine tumors, cystic teratomas and lymphangiomas. While some of these tumors are completely benign, others are either malignant or have malignant potential.

The majority of cystic pancreatic tumors have characteristic imaging features. In addition to patient age and various comorbidities, the management of cystic pancreatic tumors largely depends on their imaging characteristics, including tumor size and location and the presence of a solid component. Knowledge of these imaging characteristics may enable a radiologist to accurately differentiate benign tumors from their malignant counterparts and prevent unnecessary invasive procedures or surgical interventions. The appropriate management of cystic pancreatic tumors ranges from close imaging follow-up to surgical excision, and it is the responsibility of the radiologist to recommend an appropriate management course. Although treatment varies among centers, an algorithm for the management of cystic pancreatic tumors is shown in Fig. 2.

Common cystic pancreatic tumors

Serous cystadenoma (microcystic adenoma)

Serous cystadenomas are rare pancreatic tumors, making up 1–2% of all exocrine pancreatic tumors. They are more common in females (female:male ratio, 1.5–4.5:1) who are older than 60 years (4, 5). Hence, the term “grandmother” lesion has been coined to describe this tumor (4). Serous cystadenomas are benign and are usually found incidentally. Due to their benign nature, serous cystadenomas do not require surgical excision unless they are symptomatic. They are more common in the head of the pancreas and vary in size from 2 to 25 cm in the longest dimension (2). Typical serous cystadenomas are com-

From the Department of Radiology (M.A. ✉ drmacar@hotmail.com), Afyon Kocatepe University, Afyonkarahisar, Turkey; and the Division of Abdominal Imaging and Intervention (S.T.), Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA.

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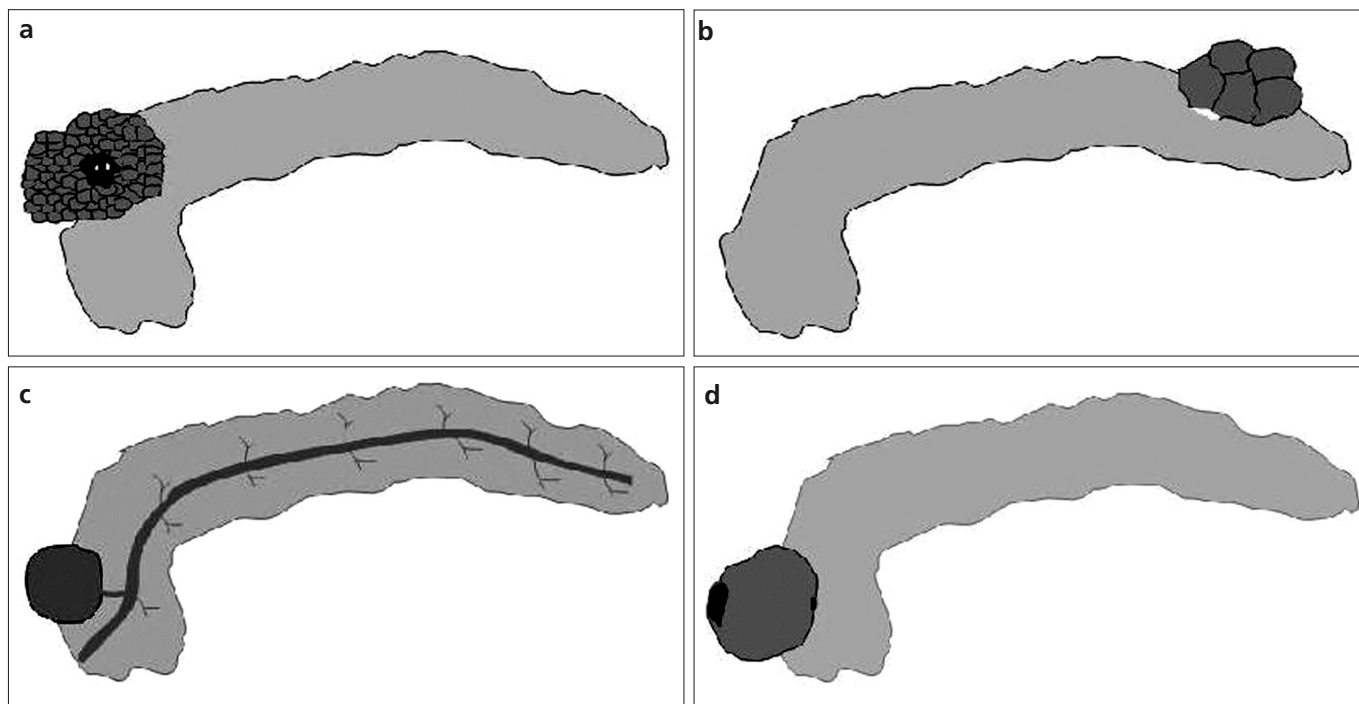


Figure 1. a–d. Schematic illustrations of four common pancreatic cystic tumors: serous cystadenoma, consisting of microcysts with a star-like central scar (*black*) and calcifications (*white*) in the head of the pancreas (**a**); mucinous cystadenoma, consisting of macrocysts with calcification (*white*) at the posterior wall in the tail of the pancreas (**b**); side-branch IPMN, communicating with the main pancreatic duct in the head of the pancreas (**c**); and SPT with solid components (*black*) in the head of the pancreas (**d**).

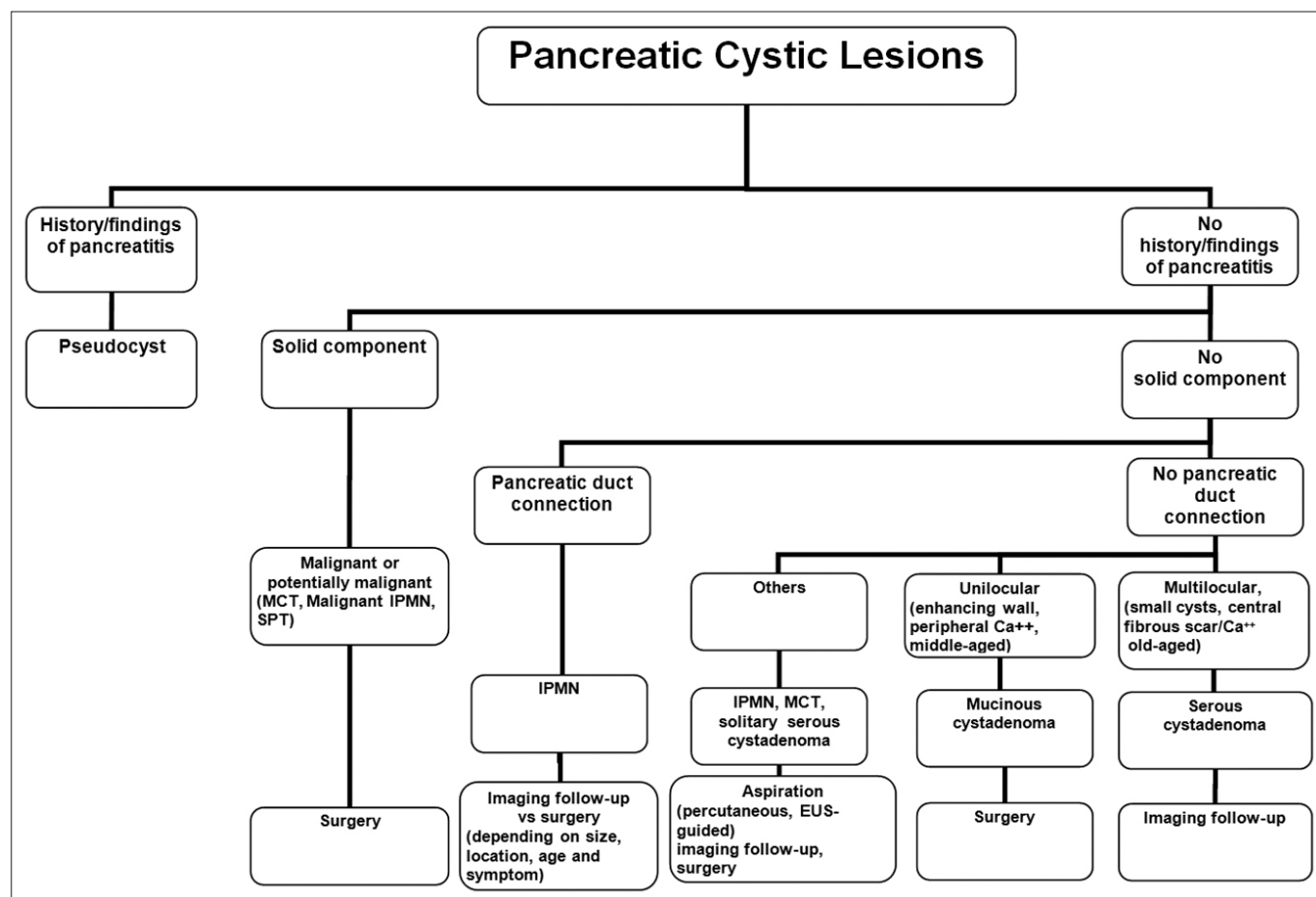


Figure 2. A schematic algorithm for the management of cystic pancreatic tumors based on imaging findings (EUS, endoscopic ultrasound; MCT, mucinous cystic tumor).



Figure 3. A 62-year-old woman who presented with a palpable epigastric mass. A contrast-enhanced axial CT image shows a large cystic pancreatic mass (*arrowheads*) composed of multiple cysts of varying sizes. A thin cyst wall and central calcifications (*arrow*) are highly characteristic of a serous cystadenoma.

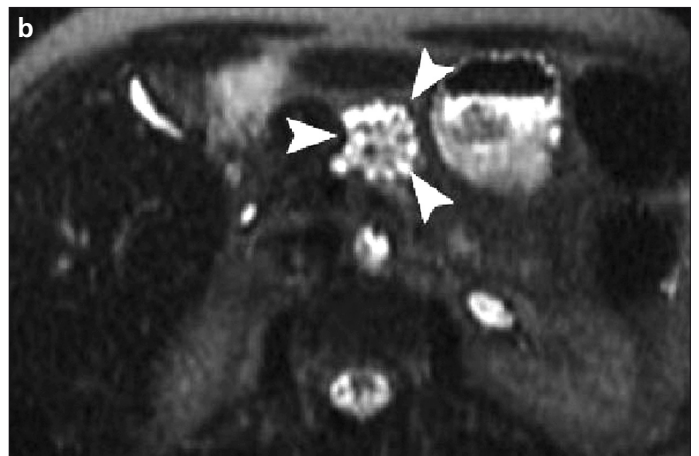
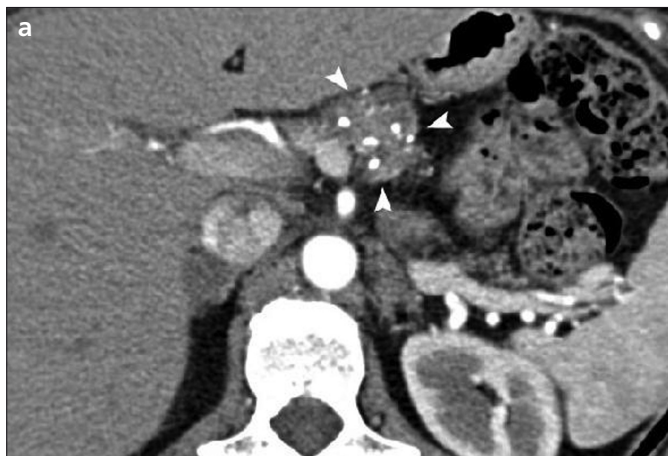


Figure 4. a–c. A 69-year-old asymptomatic woman with a pancreatic cystic mass incidentally detected on a sonographic examination. The contrast-enhanced axial CT image (**a**) shows a 2.8 x 3.0 cm heterogeneous mass (*arrowheads*) with multiple coarse calcifications at the junction of the body and neck of the pancreas. It is difficult to predict whether the mass is solid or cystic. An axial, heavily T2-weighted MR image (**b**) clearly shows that the mass consists of multiple, small, hyperintense cysts (*arrowheads*). Note the enhancement of the fibrous septations on an axial, fat-suppressed, gradient-echo T1-weighted image (**c**) that was obtained following IV gadolinium administration, which is typical for a serous cystadenoma.

posed of multiple cysts (>6) of varying sizes, from a few millimeters up to two centimeters. External lobulations and a stellate pattern are commonly present. Fibrous central scars with or without a characteristic stellate pattern of calcification are seen in 30% of cases and are highly specific to serous

cystadenomas (3) (Fig. 3). The fibrous portion of the tumor shows enhancement with an IV contrast medium on CT or magnetic resonance imaging (MRI) evaluations. This enhancement pattern is an important distinguishing feature that differentiates this type of tumor from other cystic pancreatic ne-

oplasms. On CT examination, a tumor that is composed of primarily microscopic cysts can have a solid appearance. In these cases, MRI can help to demonstrate microcysts as multiple, small, discrete, T2-bright-signal-intensity structures (Fig. 4). The fibrous components are typically hypointense

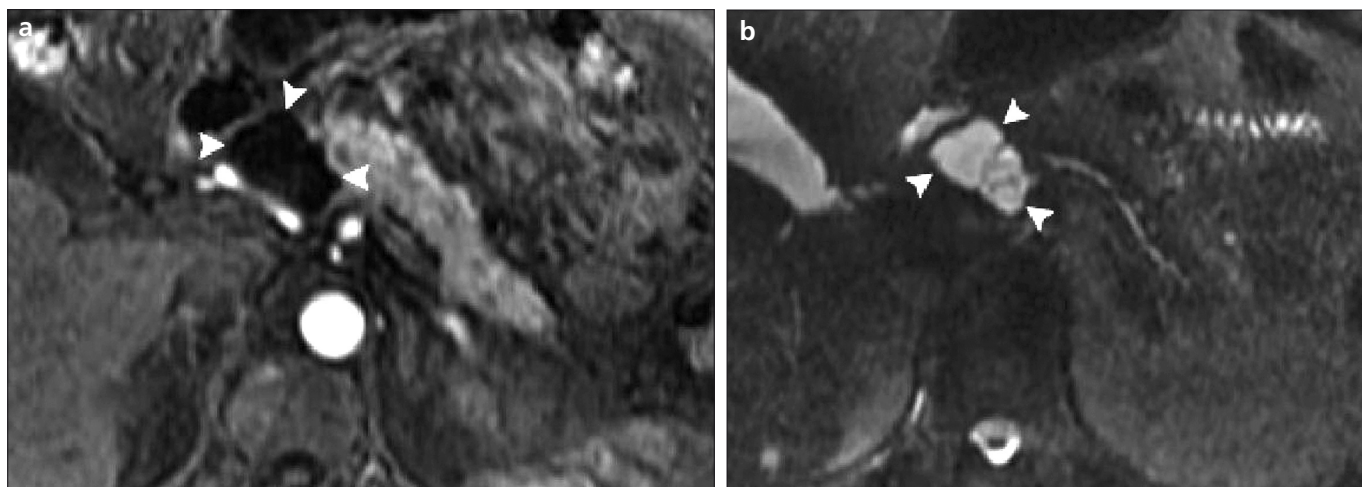


Figure 5. a, b. Mucinous cystadenoma. Axial T1-weighted contrast-enhanced (a) and heavily T2-weighted (b) MR images of a 57-year-old man. Note a nonenhancing, septated cystic mass (arrowheads) containing few macrocysts in the pancreatic neck.



Figure 6. a–c. Axial T1-weighted contrast-enhanced (a), heavily T2-weighted (b) and coronal MRCP (c) images of a 63-year-old woman. Diffuse, marked dilatation of the entire main pancreatic duct (arrow) and multiple side branches (arrowheads) are consistent with combined-type IPMN.

on T2-weighted MR images. Occasionally, serous cystadenomas may be seen as macrocystic or oligocystic variants and may be difficult to differentiate from MCT.

Mucinous cystic tumor (MCT, mucinous cystadenoma/cystadenocarcinoma)

Mucinous cystadenoma is characterized by a mucin-producing epithelium

that lines a cystic cavity. It is a benign tumor with malignant potential and occurs more frequently in women who are in their fourth through sixth decades. The term “mother” lesion has been used due to the age and gender tendencies of this tumor (4). MCTs are usually located in the body and tail of the pancreas and are commonly detected only after growing to large sizes

(Fig. 5). They are typically unilocular but can also be multilocular, containing six or fewer cysts measuring greater than 2 cm in diameter. Mucinous cystic tumors present as well-encapsulated masses with various intracystic appearances depending on their contents. Internal septations may or may not be visualized. Enhancement of the cyst wall or septations may be



Figure 7. a–d. An axial contrast-enhanced CT image of a 63-year-old woman (**a**) shows a 2.1 x 1.2 cm low-attenuation mass in the pancreatic tail (*arrowheads*), which could represent either a pseudocyst or a pancreatic neoplasm. The mass (*arrowheads*) shows no enhancement on an axial, fat-suppressed, contrast-enhanced T1-weighted MR image (**b**) and is hyperintense on an axial, heavily T2-weighted image (**c**), confirming its cystic nature. A coronal MRCP image (**d**) clearly demonstrates the communication between the cystic mass (*arrowheads*) and the main pancreatic duct (*arrow*). The findings are consistent with an IPMN. (GB, gall bladder.)

seen following contrast administration. Peripheral curvilinear calcification of the cyst wall has been reported in 10–25% of these tumors (2, 6, 7).

The most important differential diagnosis of MCT is a pseudocyst. Although a history of pancreatitis, alcoholism, or pericystic/peripancreatic inflammatory changes favor pseudocysts, some cystic lesions may be radiologically indistinguishable. Needle aspiration of cystic fluid may be helpful in these cases; while levels of amylase increase in the cystic fluid of pseudocysts, CEA levels are elevated in many MCT cases. Because MCT is considered to be a low-grade malignant neoplasm, surgical excision is the treatment of choice. Mucinous cystadenocarcinoma may be very locally aggressive, with extensive invasion of adjacent tissues. The presence of a solid component, thick wall/septa and septal calcification may be suggestive of malignancy (8).

Intraductal papillary mucinous neoplasm (IPMN)

IPMN is a mucin-secreting, papillary proliferation of the epithelial lining of the pancreatic duct that leads to obstructive dilation of the main or side branch pancreatic ducts. It presents with a wide spectrum of characteristics, varying from hyperplasia and borderline lesions to adenocarcinoma (9). In contrast to other common cystic pancreatic neoplasms, IPMN has increased prevalence in men older than 60 years. IPMNs are classified as main-duct, side-branch or combined types. The main-duct type of IPMN is characterized by segmental or diffuse dilatation of the main pancreatic duct, which may resemble chronic pancreatitis. The duct may be so much dilated as to resemble cysts. A dilated main pancreatic duct can be demonstrated with MRI, particularly using heavily T2-weighted or MR cholangiopancreatography (MRCP) images (Fig. 6).

Side-branch type IPMN is more common in the uncinate process but may also involve the body or tail; it appears as a cluster of small cysts with lobulated margins and septations (2, 10, 11). An imaging diagnosis of side-branch IPMN depends on identifying the communication of the cysts to the main pancreatic duct. This communication is generally best demonstrated by MRCP (Fig. 7). Endoscopic retrograde cholangiopancreatography (ERCP) may be helpful when MRCP fails to show any communication (Fig. 8). The management of IPMN is determined by several factors, including the size and location of the tumor, the involvement of the main pancreatic duct, the associated soft tissue component, the patient's age and surgical risk factors. While surgery is typically considered the treatment of choice for larger cysts, cysts with an associated solid component and cysts in younger patients, imaging follow-up is recom-

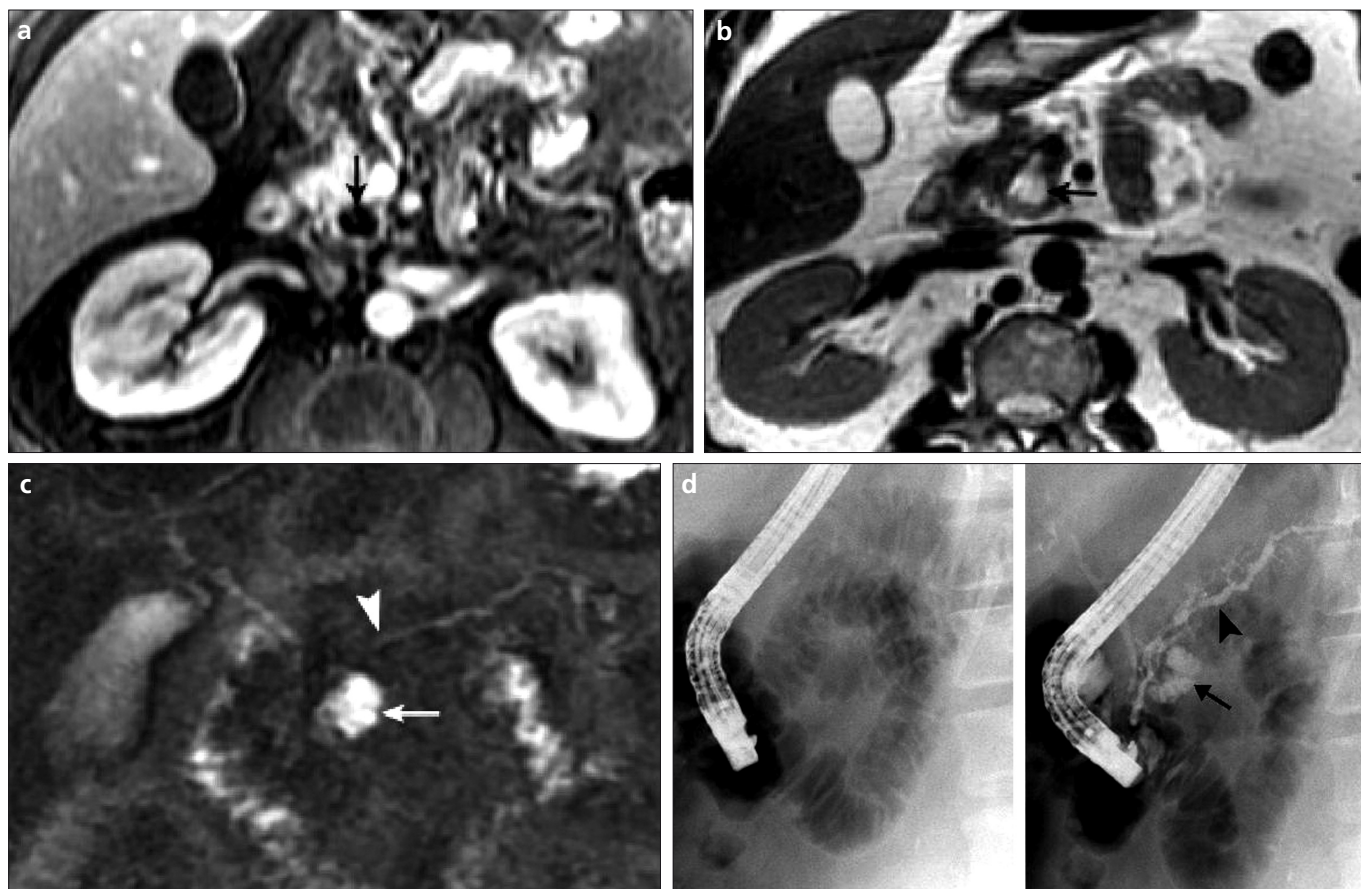


Figure 8. a–d. Axial T1-weighted contrast-enhanced (a), T2-weighted (b), coronal MRCP (c) and ERCP (d) images of a 50-year-old man. There is a well-defined 2.0 x 1.7 cm cystic mass (arrow) in the uncinate process of the pancreas. The mass is predominantly hypointense on the T1-weighted image and hyperintense on the T2-weighted image. The MRCP image demonstrates a cystic mass (arrow) with a questionable connection to the main pancreatic duct (arrowhead). ERCP clearly shows the main pancreatic duct (arrow) and extraluminal focal contrast collection (arrowhead) in the location of the mass (arrow). The findings suggest the diagnosis of a side-branch IPMN.

mended for small cysts (>3 cm) and patients of advanced age (3).

Solid pseudopapillary tumor (SPT)

SPT, also known as a solid and papillary epithelial neoplasm (SPEN), has low malignant potential and a favorable prognosis and is generally treated with surgical excision (12). These tumors mainly occur in women in their second through fourth decades. Thus, the term “daughter” has been coined to describe this type of tumor (4). Therefore, the cystic pancreatic tumor family consists of grandmother (serous cystadenoma), mother (mucinous cystadenoma) and daughter (solid and pseudopapillary) tumors. Although purely cystic or solid tumors are occasionally seen, the gross morphologic appearance of SPT is a large, encapsulated mass consisting of cystic and solid components. They typically have thick, well-defined capsules. CT, US and MR images may show internal

heterogeneity due to hemorrhage and necrosis (Fig. 9). Regions of hemorrhagic degeneration may appear as fluid-debris levels or high signal intensities on T1-weighted images (13).

Uncommon cystic pancreatic tumors

Metastases, neuroendocrine tumors, teratomas, lymphangiomas, primary pancreatic adenocarcinomas and acinar cell carcinomas may occasionally be present as cystic masses. Pancreatic metastases may develop areas of central necrosis and resemble other cystic pancreatic neoplasms. Necrotic metastases occur most often in cases of aggressive metastatic tumors, such as sarcomas, melanomas and ovarian carcinomas (4). Cystic degeneration or necrosis may also occur in pancreatic neuroendocrine tumors, adenocarcinomas and acinar cell carcinomas, usually when they grow to large sizes. Pancreatic neuroendocrine tumors, both functioning and non-

functioning, may even appear completely cystic (14, 15). The extremely rare cystic pancreatic teratoma has a variable appearance on CT evaluation, including multilocular-cystic masses. Lymphangiomas are typically benign, predominantly multiloculated, cystic, well-circumscribed tumors. Although they may be found in any part of the pancreas, they most commonly arise in the body and tail (16).

In conclusion, common pancreatic cystic tumors have characteristic imaging features, especially on MRI and MRCP examinations. Knowing these imaging features facilitates the accurate diagnosis and classification of these neoplasms and often prevents unnecessary radiological and surgical interventions. Radiologists should be aware of these imaging features and offer appropriate recommendations to accurately manage these tumors.

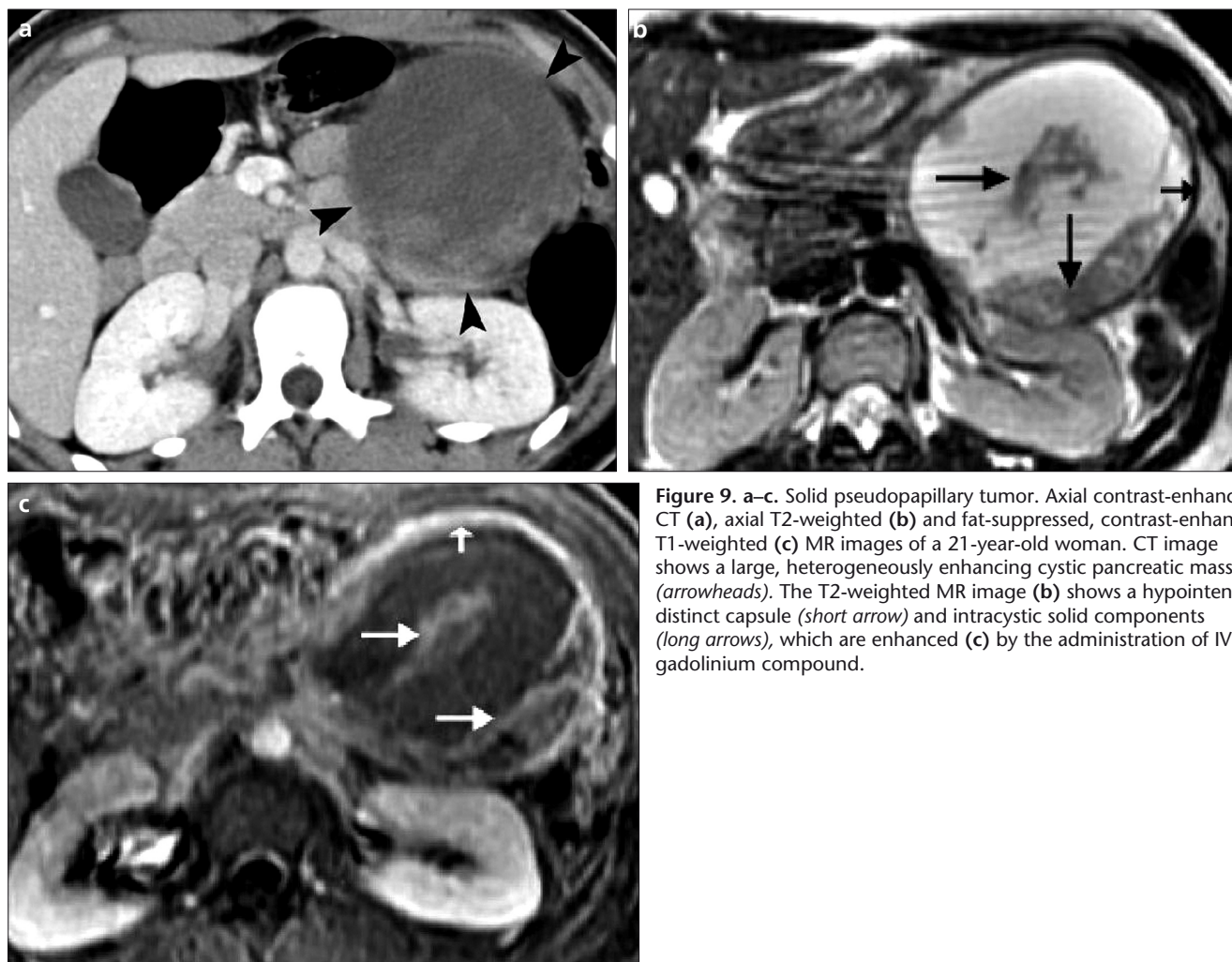


Figure 9. a–c. Solid pseudopapillary tumor. Axial contrast-enhanced CT (a), axial T2-weighted (b) and fat-suppressed, contrast-enhanced T1-weighted (c) MR images of a 21-year-old woman. CT image shows a large, heterogeneously enhancing cystic pancreatic mass (arrowheads). The T2-weighted MR image (b) shows a hypointense distinct capsule (short arrow) and intracystic solid components (long arrows), which are enhanced (c) by the administration of IV gadolinium compound.

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