Pancreatic cystic lesions are relatively common imaging findings and may be secondary to both benign and malignant disease processes. Accurate characterization of the internal features of a cyst—including fluid, hemorrhage, septa, and enhancing soft-tissue components—is important to guide the differential diagnosis, and cross-sectional magnetic resonance (MR) imaging is the optimal modality for depicting these features. Cystic lesions of the pancreas may be divided into two categories: (a) primary cystic lesions, which include pseudocysts, serous cystadenomas, various mucin-containing cysts (mucinous nonneoplastic cysts, mucinous cystadenomas, mucinous cystadenocarcinomas, intraductal papillary mucinous neoplasms), and lymphoepithelial cysts, and (b) various solid neoplasms undergoing cystic changes (ductal adenocarcinoma with cystic features, pseudopapillary tumors of the pancreas, and cystic neuroendocrine tumors). Primary cystic lesions are more common than solid neoplasms with cystic changes. Knowledge of the varied MR imaging appearances of pancreatic cystic lesions may help radiologists achieve greater specificity in diagnostic reporting.
Introduction
Cystic lesions of the pancreas encompass a variety of neoplastic and nonneoplastic processes that cause a range of clinical symptoms. With the increasing use of cross-sectional imaging, pancreatic cysts have become a common incidental finding. The accurate imaging-based characterization of pancreatic cystic lesions is necessary for appropriate patient triage and management, as some lesions require surgical intervention or follow-up imaging, whereas others require no further action. An array of imaging methods are available for assessing the pancreas. However, the evaluation of pancreatic cystic lesions involves a detailed analysis of cyst morphology and fluid content, as well as delineation of any communication with the pancreatic ductal system. Assessment of the entire pancreatic parenchyma provides additional important diagnostic information. If a definitive diagnosis can be made on the basis of the initial imaging examination, no further work-up is necessary. However, if the diagnosis is in question or a baseline imaging examination is warranted, the soft-tissue imaging contrast capabilities of magnetic resonance (MR) imaging are best suited for evaluating these features (1). The role of pancreatic cyst biopsy is debated, and a particular concern is that biopsy of a malignant fluid-containing lesion may lead to leakage of fluid from the cyst, with spread of malignant cells (2,3). Moreover, histologic analysis of needle aspirates and chemical analysis of cyst fluid produce a questionable diagnostic yield.

Pancreatic cystic lesions also may be identified at transabdominal ultrasonography (US). However, with this technique, there is an overall lack of spatial resolution and soft-tissue contrast resolution, and the quality of the images may be significantly limited in large patients. Endoscopic US provides improved visibility relative to transabdominal US, but it is invasive. Computed tomography (CT) has the capability to provide high-resolution images of the pancreas and can depict even small pancreatic cysts. Calcification also is better demonstrated at CT; however, the presence or absence of calcification has not been shown to be a critical factor in the differentiation of pancreatic cystic lesions. Moreover, cyst fluid content and internal septa are suboptimally evaluated with CT because of limited soft-tissue contrast resolution (4–6) (Figs 1, 2). Soft-tissue contrast is the major strength of MR imaging, which allows optimal depiction of the internal features of pancreatic cysts. With clearer depiction of septa and other cyst contents as well as the pancreatic ductal system, a more specific diagnosis can be achieved in many cases (4–7). The article surveys the types of cystic lesions that most often occur in the pancreas and describes their MR imaging features in detail.

MR Imaging Techniques
An optimal MR imaging evaluation of the pancreas requires rapid image acquisition with a combination of single-shot T2-weighted sequences and dynamic three-dimensional (3D) unenhanced and contrast material–enhanced T1-weighted gradient-echo (GRE) sequences. In addition, the use of multichannel phased-array surface coils is necessary for optimization of the signal-to-noise ratio.

T2-weighted imaging is important for evaluating cyst contents (fluid, septa) and the pancreatic ductal system. Multiplanar T2-weighted imaging with a single-shot fast spin-echo sequence and partial Fourier transform allows rapid acquisition of images with excellent in-plane resolution and good diagnostic quality even in freely breathing patients, although misregistration may be a relative limitation. T2-weighted imaging of the entire abdomen can be performed in 30–45 seconds with a 1.5-T magnet by using the following parameters: field of view, 350 mm²; matrix, 256 × 198; partial Fourier transform (4/8); section thickness, 7 mm; repetition time (TR) msec/echo time (TE) msec, 1500/83; flip angle, 180°. Standard turbo spin-echo sequences cannot be used to acquire all phase lines in one TR interval, so they require longer imaging times. Longer acquisition times increase image quality deterioration due to patient motion and, thus, necessitate the use of respiratory gating, which further prolongs the overall acquisition time without any definite gains in diagnostic specificity.

We apply a single-shot T2-weighted pulse sequence in both the coronal and axial planes with an additional T2-weighted sequence that includes a nonselective spectral attenuated inversion-recovery, or SPAIR, pulse to obtain fat saturation (7). Fat saturation allows the identification of acute inflammatory changes, which is especially important for the diagnosis of pancreatic pseudocysts. In addition, fat saturation may improve
Figures 1, 2. Comparison of soft-tissue contrast capabilities of CT and MR imaging. (1a) Axial contrast-enhanced CT image obtained in a 35-year-old man with acute pancreatitis depicts a fluid collection without internal complexity (arrow) in the left anterior pararenal space. (1b) Axial T2-weighted MR image obtained within 24 hours shows markedly complicated internal fluid signal within the collection (•), a finding indicative of complexity. MR images obtained after the administration of a gadolinium-based contrast material did not show internal enhancement. The diagnosis was pseudocyst. (2a) Axial contrast-enhanced CT image (5-mm section) obtained in a 68-year-old man demonstrates a focal cystic lesion in the body of the pancreas (arrow). Poor depiction of the internal architecture of the lesion limited further characterization. (2b) Axial single-shot MR cholangiopancreatographic image (8-mm section) clearly shows a cluster of many small cysts (arrow), findings in keeping with benign serous cystadenoma.

depiction of the internal architecture of a pseudocyst by suppressing the high signal intensity of fat and adjusting the overall gray scale of the image.

MR cholangiopancreatography uses heavily T2-weighted sequences that also may be applied with a single-shot technique to achieve reliable depiction of the ductal system even in freely breathing patients. Axial thin-section MR cholangiopancreatographic images (acquired with a partial Fourier transform of 4/8, field of view of 300 mm², matrix of 384 × 269, section thickness of 7 mm, TR/TE of 1500/685, and flip angle of 180°) provide excellent depiction of the ductal system, allowing the identification of small communications between cystic lesions and the pancreatic duct. Coronal thick-section acquisitions (field of view, 300 mm²; matrix, 384 × 269; section thickness, 60 mm; TR/TE, 4500/756; flip angle, 180°) can be used to obtain an overview of the ductal system on a single image. Three-dimensional MR cholangiopancreatography, another method that may be used to evaluate the biliary tree, provides higher resolution and an increased signal-to-noise ratio when compared with two-dimensional
Primary cystic lesions of the pancreas that are relatively common include pseudocysts, serous cystadenomas, and various mucin-containing cysts; lymphoepithelial cysts also occur in the pancreas, but more rarely. In addition, cystlike degeneration may occur in solid tumors of the pancreas, including pseudopapillary and cystic neuroendocrine (islet cell) tumors. Pancreatic ductal adenocarcinoma also has the potential to mimic a complex cystic pancreatic lesion when there are associated cystic changes. Cystic metastases to the pancreas are extremely uncommon and not well described in the literature.

Pseudocysts

Overall, pseudocysts are the most common cystic lesions of the pancreas. These lesions occur in the setting of pancreatitis, resulting from hemorrhagic fat necrosis and encapsulation of pancreatic secretions by granulation tissue and a fibrous capsule (10–12). The MR imaging appearance of pseudocysts may evolve over time; they are often irregularly margined early in their formation but become well circumscribed, with a thickened enhancing wall, over a period of several weeks (12). Blood products and necrotic or proteinaceous debris are commonly present and produce intrinsically increased T1 signal intensity. The thickened and enhancing cyst wall seen on images corresponds to a thick rim of granulation tissue and fibrosis that is uniformly seen at histologic analysis. Other changes of acute or chronic pancreatitis are frequently seen in association with pseudocysts, and MR imaging may be the imaging modality of choice for depicting the features of parenchymal pancreatic disease (13,14).

MR imaging has proved superior to CT for demonstrating internal complexity in pseudocysts (4) (Fig 1). Furthermore, the signal intensity increase in tissues surrounding a complicated pseudocyst on T2-weighted fat-suppressed images correlates with the degree of inflammation present. However, in patients with a pseudocyst, the cause of inflammation is more likely to be chemical irritation than infection, and it may be impossible to differentiate between an infectious process and other possible causes on the basis of imaging features alone. Clinical manifestations may be similarly unhelpful, since the symptoms of chemical ir-
Figure 3. Pancreatic pseudocyst. (a) Axial T2-weighted single-shot MR image obtained in a 45-year-old woman demonstrates a well-circumscribed, unilocular cyst in the pancreatic head. The cyst has internal signal intensity indicative of a simple fluid collection. (b) Delayed contrast-enhanced 3D GRE MR image shows chronic fibrotic changes in the pancreatic parenchyma (arrows), features suggestive of chronic pancreatitis. Surgical resection revealed a benign pseudocyst.

Figure 4. Pancreatic pseudocyst. (a) Axial T2-weighted MR image obtained in a 70-year-old woman shows a complex cyst with a fluid-debris level (arrowhead) in the pancreatic head, a finding suggestive of a pseudocyst. (b) Axial T2-weighted MR image obtained 2 months later demonstrates resolution of the pseudocyst.

Ritration may be identical to those of sepsis. Moreover, pancreatic pseudocysts may dissect along abdominopelvic fascial planes to sites remote from the pancreas (eg, liver, pleura, or mediastinum). Fistulation may occur between a pseudocyst and one or more vascular structures (15,16).

No vascularized soft-tissue elements are present within pseudocysts, and if vascularized elements are seen within a cystic lesion on contrast-enhanced MR images, the lesion is not a pseudocyst. The primary mimic of a pseudocyst is mucinous cystadenoma, and there may be significant overlap of imaging features between the two entities. In such cases, serial follow-up imaging evaluations are helpful, because pancreatic pseudocysts often evolve over short intervals (Figs 3–5), whereas mucinous cystadenomas often persist without a significant interval change. In addition, acute or chronic pancreatitis almost always is found in the presence of a pancreatic pseudocyst but is not a feature associated with mucinous cystadenoma.
**Figure 5.** Pancreatic pseudocyst. Axial unenhanced 3D T1-weighted GRE (a) and coronal T2-weighted (b) MR images obtained in a 45-year-old man depict a large cyst along the anterior pancreatic margin (arrows in a) with increased T1 signal intensity that may be secondary to hemorrhage, protein deposition, or both, common findings in pancreatic pseudocysts. Contrast-enhanced MR images showed no internal enhancement of the pseudocyst.

**Figures 6, 7.** Serous cystadenomas. Axial T2-weighted MR images obtained in a 66-year-old man (6a) and a 66-year-old woman (7a) show well-marginated pancreatic lesions, each consisting of a cluster of many small cysts separated by thin septa. In 6a, the central focal region of T2 signal hypointensity (arrowhead) from which the thin septa radiate is in keeping with a calcified scar. (6b, 7b) Axial delayed contrast-enhanced 3D GRE MR images obtained in the same two patients demonstrate thin enhancement of the internal septa (arrows), a finding suggestive of fibrous tissue. These are all features of benign serous cystadenomas.
Serous Cystadenomas

Serous cystadenomas are benign cystic neoplasms of the pancreas that occur frequently in older women (median age, 65 years) (17). Serous cystadenomas are composed of numerous small cysts that are conjoined in a honeycomblike formation. The size of these cysts ranges from 0.1 to 2.0 cm but typically is less than 1 cm. The cysts are lined by glycogen-rich epithelium and separated by fibrous septa that radiate from a central scar, which may be calcified. This formation has led to the use of the more descriptive term microcystic pancreatic lesion (18). Serous cystadenomas are usually discovered incidentally at imaging; however, those that are large may cause symptoms such as abdominal pain or, more rarely, jaundice. Progressive enlargement of serous cystadenomas—especially those with a size of 4 cm or more at initial manifestation—may be seen at serial follow-up imaging examinations performed over a period of months or years (19). Multiple serous cystadenomas may occur in von Hippel–Lindau disease (20).

At MR imaging, a serous cystadenoma appears as a cluster of small cysts within the pancreas, with no visible communication between the cysts and the pancreatic duct (1). The cysts show signal intensity of simple fluid on T2-weighted images, and the thin fibrous septa between them enhance on delayed contrast-enhanced MR images (Figs 6, 7). As the lesion grows, fibrous tissue retraction produces the pattern of a central scar, which likely represents fibrotic walls of a collapsed, centrally located cyst. Enhancement of these fibrous septa at CT may be misleading (Fig 2), but the finding of a cluster of small fluid-containing cysts at MR imaging is usually diagnostic. When coarse calcification is present in the central scar, a corresponding signal void may be seen on MR images obtained with any pulse sequence (Figs 6, 7).

In addition to the classic microcystic form of serous cystadenoma, there are less common types, including oligocystic and solid variants. In the oligocystic variant, the serous cysts are larger and fewer, and the overall imaging appearance of the lesion may mimic that of a mucinous cystadenoma (Fig 8). Solid serous cystadenomas are even less common and are composed of microscopic serous cysts. These tumors may appear at MR imaging as solid, well-circumscribed, well-vascularized pancreatic masses with imaging features that overlap with those of pancreatic neuroendocrine tumors. The T2 signal intensity of these tumors is variable and may not approach that of fluid; presumably, the microscopic cysts are too small to be reliably depicted on MR images.

Figure 8. Oligocystic serous cystadenoma. Axial T2-weighted (a) and delayed contrast-enhanced 3D GRE (b) MR images obtained in a 26-year-old woman show a cystic pancreatic lesion (arrow) that consists of several large cysts and lacks internal enhancing soft-tissue components. This oligocystic variant of serous cystadenoma (a diagnosis confirmed with surgical resection) has imaging features that overlap with those of mucinous cystadenoma.
Mucin-containing Cysts

**Mucinous Nonneoplastic Cysts.**—Described in 2002 by Kosmahl et al (21), mucinous nonneoplastic cysts of the pancreas show mucinous differentiation of the epithelial lining but lack the surrounding ovarian stroma that is characteristic of mucinous cystadenomas. These nonneoplastic cysts also do not demonstrate ductal communication, cellular atypia, or the papillary projections seen in intraductal papillary mucinous neoplasms (IPMNs). Unlike IPMNs and mucinous cystadenomas, they are believed to have no neoplastic potential (21). Their benign histologic features correlate well with their MR imaging features. The cysts are typically small and unilocular or thinly septate, and they have internal signal intensity of simple fluid, with no enhancing soft-tissue components (Fig 9). It is possible that many of the small, unilocular cysts incidentally found at imaging represent mucinous nonneoplastic cysts of the pancreas. The MR imaging appearance of mucinous nonneoplastic cysts may be indistinguishable from that of mucinous cystadenomas, especially if the cyst is large and has a thick wall. A noteworthy differential consideration is the fact that mucinous nonneoplastic cysts have no proven sex predilection, whereas mucinous cystadenomas are seen overwhelmingly in female patients (22).

**Mucinous Cystadenomas.**—Mucinous cystadenomas account for approximately 10% of pancreatic cystic neoplasms (11). These cystic lesions often have thickened walls that are lined by mucin-producing columnar epithelium (17). The distinguishing pathologic feature of the cysts is the presence of a surrounding ovarian-type stroma similar to that seen in biliary cystadenomas. Unlike IPMNs, mucinous cystadenomas do not communicate with the pancreatic ductal system. The vast majority (>95%) of mucinous cystadenomas have been found in women (mean age, 47 years), typically in the body or tail of the pancreas (17,22,23). Mucinous cystadenomas have malignant potential, and adequate sampling of the cyst lining must be performed for pathologic analysis to determine whether foci of dysplasia or carcinoma in situ are present.

At MR imaging, a mucinous cystadenoma commonly manifests as a unilocular or mildly septate cystic lesion (Fig 10). The wall of the cyst is typically thick and enhances at delayed contrast-enhanced MR imaging, findings that correlate...
with fibrotic changes seen at histologic analysis. Although the cyst fluid is typically mucin filled, the most common MR imaging characteristics are those of simple fluid, with homogeneous low T1 signal intensity and homogeneous high T2 signal intensity. Increased intrinsic T1 signal intensity of the fluid in mucin-containing cysts also has been observed (24), but this imaging feature may be less reliable. Mildly thickened, enhancing septa often are present in mucinous cystadenomas (Fig 11); however, the presence of internal enhancing soft-tissue elements is indicative of carcinoma.

**Mucinous Cystadenocarcinomas.**—When invasive carcinomatous elements are present in a mucinous cyst with a surrounding ovarian-type stroma, the lesion is a mucinous cystadenocarcinoma. Patients with a new diagnosis of invasive carcinoma are significantly older on average than those with a new diagnosis of noninvasive mucinous cystadenoma; this statistic is suggestive of a progression from cystadenoma to cystadenocarcinoma (23).

**Figures 10, 11.** Mucinous cystadenoma. (10a) Axial T2-weighted fat-saturated MR image obtained in a 56-year-old woman depicts a single large lobulated cyst (arrow) in the pancreatic neck, a finding suggestive of mucinous cystadenoma. (10b) Coronal contrast-enhanced T1-weighted MR image shows no internal enhancing soft-tissue elements suggestive of carcinoma. (11a) Axial T2-weighted MR image obtained in a 48-year-old woman shows a rounded thick-walled cystic structure (arrow) in the pancreatic tail. (11b) Contrast-enhanced 3D GRE MR image shows multiple thickened enhancing septa along the posterior margin of the cyst (arrowheads).
Figure 12. Mucinous cystadenocarcinoma. (a) Axial T2-weighted MR image obtained in a 55-year-old man shows a large, complex cystic lesion (arrow) in the pancreatic head. (b, c) Unenhanced (b) and contrast-enhanced (c) 3D GRE MR images show enhancing mural soft-tissue elements (arrowheads in c) projecting toward the cyst center, features that represent carcinomatous components.

Figure 13. IPMN with involvement of the main pancreatic duct. Axial T2-weighted MR images obtained in a 70-year-old man (a at a lower level than b) show diffuse dilatation of the main pancreatic duct with a focal cystic lesion in the pancreatic head. The lesion communicates with the distended main pancreatic duct (arrowhead in a). These findings represent an IPMN with involvement of the main pancreatic duct.

Figure 14. IPMN. Axial T2-weighted MR image obtained in a 72-year-old man demonstrates focal dilatation of ductal side-branches in the pancreatic head (arrow), findings that represent a small side-branch IPMN.
Mucinous cystadenocarcinomas manifest at MR imaging as large complex cystic pancreatic lesions. They may be distinguished from mucinous cystadenomas by the presence of intracystic enhancing soft tissue (Fig 12). In a retrospective review of 163 resected mucinous cysts with surrounding ovarian-type stroma, 17.5% of the cysts contained elements of invasive carcinoma at histologic analysis. All of the lesions with an invasive carcinomatous component had a size of 4 cm or more and demonstrated soft-tissue nodularity. Hence, any enhancing soft tissue within a cystic neoplasm depicted on MR images is considered an indication for resection.

Pancreatic IPMNs.—IPMNs of the pancreas were first described relatively recently; the term was coined by Sessa et al in 1994 (25). IPMNs are mucinous cystic tumors of the pancreas that are clinically and histopathologically distinct from mucinous cystadenomas. They occur most frequently in men (mean age, 65 years) (17). The tumors are characterized by a mucinous transformation of the pancreatic ductal epithelium, which usually demonstrates papillary projections at histologic analysis (11,26). Excessive mucin production by the neoplastic cells results in cystic dilatation of the pancreatic duct and, possibly, spillage of mucin from the ampulla of Vater, a classic finding at endoscopic retrograde cholangiopancreatography. IPMNs range from noninvasive neoplasms with varying degrees of epithelial dysplasia (Figs 13, 14) to foci of carcinoma in situ and frank invasive adenocarcinoma (Fig 15).

IPMNs may be classified according to whether the disease process involves the main pancreatic duct (Fig 13) or isolated side branches (Fig 14). They also may be characterized according to whether they produce a diffuse pattern of ductal dilatation or a segmental cystic appearance (11). The location of the tumor is an important factor for the prognosis (27). Main duct IPMNs are more likely to be malignant, with approximately 60%–70% of cases demonstrating invasive carcinoma (28,29), whereas only 22% of branch duct IPMNs demonstrate foci of carcinoma (30). IPMNs are frequently multifocal, and 5%–10% involve the entire pancreas (31).

MR imaging is the modality of choice for characterizing IPMNs and provides better depiction of ductal communication than CT (5,6). The location and type of an IPMN determine its MR imaging appearance. In tumors that involve the main pancreatic duct, ductal dilatation is a reliable feature and may be observed along the entire length of the duct or within a segmental portion (17,26). Although diffuse ductal dilatation is present also in cases of advanced chronic pancreatitis, there are parenchymal signal intensity changes, such as loss of T1 signal and delayed uptake of contrast material, which are indicative of chronic fibrosis (14). Among IPMNs involving the pancreatic ductal side branches, dilatation of multiple side branches on T2-weighted images is the most common finding, and it is usually seen in the pancreatic head (32). A tumor that involves side branches also may have a more segmental cystic appearance and may mimic a mucinous cystadenoma; however, the observation of ductal communication helps differentiate between these two entities.
Lymphoepithelial Cysts

Lymphoepithelial cysts of the pancreas are rare (34), and the imaging findings are not well described in the literature. These benign pancreatic cysts occur most commonly in men (mean age, 55 years) (34). The cysts are lined by squamous epithelium and surrounded by dense lymphoid tissue. Their MR appearances vary, and they may be either unilocular or multilocular (34,35).

Solid Pancreatic Tumors with Cystic Degeneration

Ductal Adenocarcinomas with Cystic Features.—Ductal adenocarcinoma, the most lethal tumor of the pancreas, is also the most common, accounting for 90% of pancreatic neoplasms (1). Related mortality is high, with a 5-year survival of less than 3%. The growth pattern of these tumors is usually infiltrative, with resultant obstruction of the pancreatic duct (or the common bile duct, when the tumor is located...
Solid pseudopapillary tumors of the pancreas. (a) Axial T2-weighted MR image obtained in a 38-year-old man shows a large, predominantly solid tumor in the pancreatic head, with a central focus of T2 signal hypointensity (arrowhead) that appeared hyperintense on T1-weighted unenhanced images and correlated with a focal hemorrhage at histologic analysis. (b, c) Axial contrast-enhanced GRE MR images from arterial (b) and delayed (c) phases show a gradual accumulation of contrast material in the tumor (arrow).

Solid Pseudopapillary Tumors.—Previously known as solid and cystic papillary epithelial neoplasms of the pancreas or as papillary cystic neoplasms, these uncommon lesions were named solid pseudopapillary tumors of the pancreas by the World Health Organization in 1996 (37). The tumors occur predominantly in women (mean age, 28 years) and have low-grade malignant potential (17). The cellular lineage of the tumors remains uncertain, with both epithelial and neuroendocrine differentiation having been suggested by various authors. The tumors occur exclusively in the pancreas and have no corollary in other organ systems.

The classification of solid pseudopapillary tumors as cystic pancreatic lesions may lead to confusion at imaging because in many cases the tumors are completely solid. Cystic components are secondary to tumor degeneration, and they vary in both size and morphology. On T2-weighted MR images, pseudopapillary tumors are well circumscribed. Those that are predominantly solid have mildly increased T2 signal intensity, and those that are mostly cystic have T2 signal intensity closer to that of fluid (Figs 18–20). Enhancing soft-tissue components are uniformly present,
Figures 19, 20. (19) Solid pseudopapillary tumors of the pancreas. (a) Axial T2-weighted MR image obtained in a 43-year-old woman depicts a well-circumscribed tumor (arrow) with complex internal signal intensity. (b) Axial unenhanced T1-weighted 3D GRE MR image shows a region of high signal intensity within the tumor (arrowhead), a finding that represents blood products from tumor degeneration. (c) Coronal contrast-enhanced subtraction MR image demonstrates a small amount of vascularized soft tissue (arrowhead) within the tumor. (20) Axial (a, b) and coronal (c) T2-weighted MR images obtained in three patients depict solid pseudopapillary tumors with varying degrees of cystic degeneration: one predominantly solid (arrow in a), one mixed solid and cystic (arrow in b), and one predominantly cystic (arrow in c).
allowing the differentiation of these tumors from cystic lesions such as mucinous cystadenomas; however, the MR imaging features may overlap with those of mucinous cystadenocarcinomas. The enhancement pattern demonstrates a gradual accumulation of contrast material within the tumor, helping differentiate pseudopapillary tumors from neoplasms such as neuroendocrine tumors, which show early arterial enhancement. Hemorrhage, another common feature secondary to tumor degeneration, manifests at MR imaging as intrinsically increased T1 signal intensity within the lesion (Fig 19b).

The primary differential consideration at MR imaging is a neuroendocrine tumor, which bears some morphologic similarity to a pseudopapillary tumor even at cytologic analysis. Another differential consideration in cases of a predominantly cystic tumor with a solid component is mucinous cystadenocarcinoma. However, because all three entities require surgical resection, their preoperative differentiation may not be important in the clinical setting.

Cystic Neuroendocrine Tumors. —Cystic neuroendocrine tumors are an uncommon subgroup of pancreatic neuroendocrine tumors, which are typically solid and well vascularized. Cystic neuroendocrine tumors most often occur in adults (mean age, 53 years) and show no sex predilection (38). Cystic change in a pancreatic neuroendocrine tumor is an uncommon manifestation of an already rare neoplasm, although cystic components were found in 10 (17%) of 170 resected neuroendocrine tumors in a recent study (38). Cyst formation in neuroendocrine tumors is believed to be secondary to tumor degeneration (26).

Identification of a cystic neuroendocrine tumor at imaging is a challenge and relies on the observation of vascularized soft-tissue components. Even in neuroendocrine tumors that are more than 95% cystic, the diagnosis may be suggested by the presence of a rim of well-vascularized tissue that enhances avidly in the arterial phase, a feature that correlates with the cytologic finding of neoplastic neuroendocrine cells lining the cyst periphery (Fig 21). Cystic neuroendocrine tumors, like solid neuroendocrine tumors, are predominantly well circumscribed, in keeping with cystic degeneration of a solid lesion. Correlation of imaging findings with the clinical history is necessary, since a patient with a cystic neuroendocrine tumor is significantly more likely to have an underlying multiple endocrine neoplasia syndrome than a patient with a uniformly solid neuroendocrine tumor (38).

Conclusions
Cystic lesions of the pancreas represent a wide range of benign and malignant pathologic entities, many of which have specific features that are well demonstrated at MR imaging. The capability of MR imaging for depicting soft tissues allows optimal evaluation of the internal architecture of a cyst and the underlying pancreatic parenchyma, as well as optimal demonstration of enhancing soft-tissue elements. MR imaging with a combination of rapid T2-weighted sequences and unenhanced and contrast-enhanced T1-weighted sequences facilitates both the initial diagnosis and the clinical management of pancreatic cysts.
References


MR Imaging of Cystic Lesions of the Pancreas

Bobby Kalb et al

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At MR imaging, a serous cystadenoma appears as a cluster of small cysts within the pancreas, with no visible communication between the cysts and the pancreatic duct. The cysts show signal intensity of simple fluid on T2-weighted images, and the thin fibrous septa between them enhance on delayed contrast-enhanced MR images.

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