**Image of incidental cystic lesions of the pancreas**

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**Résumé**

**Imagerie des lésions kystiques du pancréas de découverte fortuite**

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Les lésions kystiques du pancréas, dont la prévalence a été évaluée à 20%, sont le plus souvent diagnostiquées en imagerie chez des patients asymptomatiques. Parmi ces lésions, les pseudokystes habituellement associés à un contexte de pancréatite doivent être éliminés en priorité. La caractérisation des tumeurs kystiques est plus difficile. Il est cependant essentiel de pouvoir orienter le diagnostic vers une lésion bénigne ou une lésion maligne. Le scanner multi-slices et l’IRM permettent de caractériser ces lésions dans plus de 75% des cas. Si la lésion reste indéterminée, on doit réaliser une écho-endoscopie, avec ponction-aspiration et analyse biochimique en particulier pour le diagnostic de lésions muco-sécrétrices (ronde à paroi épaisse prenant le contraste). Lorsque ces moyens d’imagerie n’ont pas permis de caractériser une lésion kystique du pancréas, on peut proposer une ablation thérapeutique avec surveillance du patient si elle s’agit d’un kyste de taille inférieure à 3 cm et, si sa morphologie est soit uniloculaire ronde à paroi fine ne prenant pas le contraste (kyste simple) soit à contour lobulé multiloculaire à paroi fine ne prenant pas le contraste (cytadénome séreux, TIPMP d’un canal secondaire isolée). Cette surveillance montre que la plupart des kystes évoluent peu dans le temps. La prise en charge thérapeutique doit donc considérer la durée de survie prévisible du patient sans aucune intervention comparée aux risques induits par l’exérèse chirurgicale (morbidité, mortalité, séquelles en fonction du geste envisagé).

**Mots-clés** : Pancréas. Lésions kystiques. Tumeur.

**Abstract**

Cystic lesions of the pancreas, with an estimated prevalence of 20%, frequently are incidental findings at imaging on asymptomatic patients. Pseudocysts, typically in a setting of pancreatitis, should first be excluded. Characterization of cystic tumors is more complicated. Still, it is important to differentiate between benign and malignant lesions. Multi-detector row CT and MRI allow characterization of such lesions in over 75% of cases. Indeterminate lesions should undergo endoscopic US with biopsy/aspiration and fluid analysis, especially for mucin producing tumors (rounded with thick enhancing wall). When imaging fails to fully characterize a lesion, follow-up may be proposed for lesions less than 3 cm in size, that are either unilocular with thin nonenhancing wall (simple cyst) or lobulated multilocular with thin nonenhancing wall (serous cystadenoma, isolated side branch IPMTP). Follow-up imaging shows that these tumors usually show very little change over time. Management is based on comparing estimated patient survival without treatment to surgical risks (morbidity, mortality, functional sequelae from the procedure).

**Key words** : Pancreas. Cystic lesions. Tumors.


**Due to advances in cross-sectional imaging techniques, cystic lesions of the pancreas are increasingly being detected in asymptomatic patients. Their prevalence has been estimated to 20% on imaging and autopsy series (1, 2). As such, it is important to be familiar with the CT and MR imaging features of cystic lesions of the pancreas to orient the diagnosis towards benign or malignant lesion (3, 4). Cystic lesions of the pancreas include a wide variety of lesions, and the first step in interpretation is to exclude the possibility of pseudocyst, typically associated with a history of pancreatitis (5). Characterization of cystic tumors of the pancreas often is difficult because imaging features frequently overlap between several histological tumor types (6). Currently, multidetector row CT (MDCT) and MR allow characterization of cystic tumors by expert teams in over 75% of cases (3). Endoscopic US (EUS) with biopsy-aspiration is a second line imaging modality, especially for the diagnosis of mucinous lesions (7). When imaging cannot adequately characterize a cystic lesion of the pancreas, follow-up may be proposed (8). Because most lesions are stable at follow-up, management must consider the estimated life expectancy of the patient versus the surgical risk. After a brief review of the anatomopathological classification of cystic tumors of the pancreas, the imaging features of the main cystic lesions of the pancreas will be presented, including some diagnostic pitfalls. We will then discuss some questions raised by the management of these patients and propose a work-up algorithm for the follow-up of these asymptomatic patients.**

**Anatomopathology**

Lesions are classified as non-tumoral cystic lesions and tumoral cystic lesions. Non-tumoral cystic lesions include:
– isolated single cysts such as true cyst and lymphoepithelial cyst (very rare), or multiple cysts such as with Von Hippel-Lindau disease or in association with polycystic renal disease;
– post-pancreatitis or post-traumatic pseudocysts;
– parasitic cysts such as hydatid cysts (exceptional in the pancreas).

Tumoral cystic lesions include epithelial tumors of the exocrine pancreas, epithelial tumors of the endocrine pancreas, and non-epithelial tumors.

Tumors of the exocrine pancreas include serous and mucinous cystadenomas. These are the most frequent tumors and the only ones with primary cystic organization with epithelial lining of the cyst wall, with or without internal septations delineating one or more cyst(s) of variable fluid composition. The other epithelial cystic tumors have a cystic component due to necrosis or abundant secretion of mucous, such as intraductal papillary mucinous tumors (IPMT) of the pancreas, solid pseudopapillary tumor of the pancreas, mucinous adenocarcinoma, and acinic cell carcinoma of the pancreas.

Tumors of the endocrine pancreas (functioning or non-functioning) can appear cystic on imaging.

Finally, non-epithelial cystic tumors are extremely rare and include cystic schwannomas, teratomas, sarcomas, and lymphangiomas.

**Imaging techniques**

After incidental detection of a cystic lesion of the pancreas, typically on abdominal US, the three imaging studies to propose are, in the following order, MDCT, MR and EUS. These examinations are complementary and each exam increases the diagnostic accuracy.

MDCT has excellent spatial resolution. A typical pancreatic protocol includes thin images (2-3 mm) prior to and after intravenous administration of iodinated contrast material (2 ml/kg, at 3 ml/sec) at a pancreatic phase (40-45 sec) and parenchymal phase (70-80 sec) with 2D or 3D reformatting images (9).

MR of the pancreas, including MR pancreatography (MRP), provides excellent contrast resolution (10). MR allows detection of septations and intracystic nodules, and, in combination with the heavily T2-weighted MRP sequences, fluid-filled structures, especially microcysts and the pancreatic duct. The protocol includes axial T1-weighted and T2-weighted images of the pancreas along with MRP sequences. Axial T2-weighted images include breath-hold HASTE-like and free-breathing fat-suppressed fast spin echo sequences with respiratory gating. T1-weighted images may include fat-suppressed gradient-echo or in and out of phase sequences. Imaging after intravenous administration of gadolinium (0.1 mmol/kg) is performed using 2D or 3D fat-suppressed gradient-echo sequences during the arterial (20-25 seconds), portal venous (60-65 seconds) and delayed (3-5 minutes) phases. 3D acquisitions provide better spatial resolution with thinner images than 2D acquisitions with the added possibility of vascular reconstructions. MRP acquisitions include breath-hold 2D RARE-like or SS-TSE-like sequences in the oblique coronal and axial planes with slice thickness between 20-40 mm centered over the pancreaticobiliary confluence and left-sided portion of the main pancreatic duct, or 3D-TSE restore sequences with multiplanar reformations. EUS also provides good spatial resolution allowing detection of microcysts to confirm a diagnosis of serous cystadenoma and detection of intracystic abnormalities (11). Mural thickening, septations and mural nodules are suggestive of malignancy but 60% of benign lesions present imaging features simulating the presence of these findings (12). The main advantage of EUS is the ability to perform cyst aspirations for intracystic markers and cytology. This allows diagnosis of mucin-producing tumors by demonstrating positive cytology and elevated CA 19-9 (>50,000 U/ml) and CA 72-4 (>40 ng/ml) with sensitivity of 57%, 72% and 73% and specificity of 99%, 84%, and 99% respectively (13, 14). Dosage of intracystic mucin is no longer performed.

The role of PET-CT is currently under evaluation for the diagnosis of cystic tumors of the pancreas, especially to differentiate mucinous from non-mucinous lesions. Recently, a prospective study of 50 patients with cystic lesion of the pancreas showed a diagnostic accuracy of 18-FDG PET-CT of 94% for detecting malignant cystic lesions (15).

**Imaging features of the main cystic lesions of the pancreas**

**Simple serous or true pancreatic cyst**

It corresponds to a non-communicating cyst with non-secreting epithelial lining. It is frequently described in the pathologic literature and represents 47.5% of small pancreatic cysts on autopsy series (1). There is no malignant potential. A single cyst may be present or multiple cysts may occur in patients with VHL or polycystic renal disease.

On imaging, it corresponds to a thin walled non-enhancing unilocular round or oval shaped cystic lesion, less than 1 cm in size, best depicted on MR (1). It is more frequent in patients over 70 years of age, where it also tends to be larger (>1 cm) and more frequently multiple (1).

**Pseudocysts**

Pseudocysts corresponded to less than 4% of asymptomatic patients with cystic lesion of the pancreas who underwent surgery (16). These collections are rich with pancreatic enzymes and necrotic tissue, limited by a wall (fibrous capsule) of variable thickness, intra or extra-pancreatic in location, most frequently occurring after a known episode of pancreatitis, in patients with chronic calcifying pancreatitis or after pancreatic trauma (5). CT is the gold standard for diagnosis with demonstration of a well-defined unilocular fluid collection with wall of variable thickness and rim-enhancement after injection of contrast material (fig. 1). Calcifications may be present (fig. 2). The presence of gas indicates infection of fistulization. Hyperdense components indicate hemorrhage (fig. 3). MR is useful to demonstrate communications with the pancreatic duct (fig. 4).

Pseudocysts may simulate cystic tumors, but the clinical setting and associated pancreatic abnormalities should suggest the correct diagnosis.

**Serous cystadenomas**

They are the most frequent cystic tumor of the pancreas. In the series by Le Borgne et al. (17) it corresponded to 32% of cystic tumors in asymptomatic patients. They are benign tumors for which therapeutic abstinence is usual. They occur at a mean age of 50-70 years old, have a female sex predilection (sex-ratio 2:1), are usually single and rarely multiple, have no preferential site of involvement in the pancreas, and are sometimes associated to VHL. Three forms are described on imaging: typical microcystic, uni- or multilocular macrocystic and solid.

The typical microcystic type (70%) has a “honeycomb” multilocular architecture...
after injection of contrast due to the presence of a cluster of cysts (>6) of small size (few mm to 2 cm) separated by thin enhancing septations sometimes forming an enhancing central scar that may calcify (fig. 5 and 6). The microcysts needed to diagnose a serous cystadenoma are well depicted on T2-weighted MR images where they appear hyperintense and surrounded by hypointense septations and central scar (fig. 7). MR shows a single lesion and absence of pancreatic ductal communication, which are useful features to differentiate between serous cystadenoma and IPMT (intraductal papillary mucinous tumors of the pancreas), though this distinction may remain challenging at times.

The macrocystic type (25%) is divided into two subgroups: the mixed type with large (>2 cm) cysts often multiple, and the unilocular type corresponding to 10% of serous cystadenomas. The differential diagnosis for the unilocular type includes mucinous cystadenoma and pseudocyst. Cohen-Scali et al (18) have described four diagnostic imaging features on CT to characterize unilocular macrocystic serous cystadenomas of the pancreas: location in the pancreatic head, lobulated contour, absence of wall enhancement and wall thickness less than 2 mm. When two of these four criteria were used in combination, 83% of patients with unilocular macrocystic serous cystadenoma were identified and when three or four of these criteria were used, a specificity of 100% was achieved (18). These results were recently confirmed by Kim et al who proposed a classification of macrocystic lesions of the pancreas into three subgroups based on their morphological CT features (19).

Serous adenomas tended to have a multicystic or lobulated shape, whereas mucinous cystadenomas tended to have a smooth shape and be well-defined and side-branch IPMT's tended to have a pleomorphic cystic shape (containing at least three oval or tubular cysts) (19).
The solid type (5%) is characterized by a solid tumor with homogeneous enhancement due to enhancing septations (containing multiple vessels on histology) and absence of visualization of tiny cysts (20). Sometimes, the central scar may be large, nodular and eccentric, simulating a solid mass with cystic component. The identification of a microcystic architecture is necessary to suggest this diagnosis (fig. 8). The main differential diagnosis is with endocrine tumors. Somatostatin-receptor scintigraphy (OctreoScan) or biopsy are required for diagnosis.

**Mucinous cystadenomas**

Mucinous cystadenomas are benign tumors with malignant potential that may degenerate into cystadenocarcinomas. Therefore, all suspected mucinous cystadenomas should be surgically resected. In the series of Le Borgne et al (17), mucinous cystadenomas and mucinous cystadenocarcinomas corresponded to 26% and 14% of cystic tumors respectively in asymptomatic patients. Mucinous cystadenomas typically are single lesions involving the body and tail of the pancreas that occur in patients 50-60 years of age, with female predominance (sex ratio 9:1) (21). On imaging, they tend to be rounded, unilocular (or oligolocular, <6), composed of one or a few large macrocysts (>2 cm), with enhancing wall and septations allowing detection of irregular wall thickening and mural nodules (fig. 9). MR is useful to demonstrate septations and mural nodules, also well visualized on EUS (fig. 10). On T1-weighted images, cysts show variable signal intensity, sometimes hyperintensity due to hemorrhagic or mucinous fluid.

Imaging features alone are not sufficient to distinguish benign mucinous adenoma from cystadenocarcinoma (pancreatic head involvement in 60% of cases, sex ratio 1:1). Malignant degeneration may be minimal, limited to a small portion of the wall of a cyst, or extensive with tumor mass at the periphery of a cyst (fig. 11). Diagnosis is more straightforward in the presence of a tumor mass, suspicious adenopathy, vascular involvement or liver metastases. EUS is most accurate for detection of findings suspicious for malignancy, especially the presence of a mural nodule with direct invasion of the adjacent pancreatic parenchyma.

**Fig. 4:** Pancreatic pseudocyst communicating with the pancreatic duct. T2-weighted MR of the pancreas showing communication between the hyperintense collection and the pancreatic duct.

**Fig. 5:** Serous cystadenoma of the pancreatic head.  
\[a\] Noncontrast CT: hypodense lesion with central calcifications.  
\[b\] Postcontrast CT showing enhancement of the fibrous septations.

**Fig. 6:** Serous cystadenoma of the pancreatic tail. Postcontrast CT showing a hypodense microcystic lesion with central calcifications.
Intraductal papillary mucinous tumors (IPMT) of the pancreas

IPMTs are mucin-producing intraductal tumors with malignant potential. They cause cystic dilatation of the pancreatic duct. In the series of Beaujon (22), 20% of IPMTs were incidental findings. IPMTs typically involve the head and body of the pancreas and occur in patients with a mean age of 60 years, with slight female predominance. Presenting symptoms include abdominal pain, pancreatitis, diabetes, chronic pancreatitis and jaundice. Three types are described: the main duct type, the side branch type and the mixed type (most frequent) with involvement of both the main duct and side branches (fig. 12).

Side branch IPMTs may be difficult to differentiate from other cystic lesions (23). Side branch IPMTs appear as single unilocular or multilocular cystic lesions with grape-like clusters (pleomorphic cystic shape, i.e., containing oval or tubular cysts), without wall enhancement, typically involving the head of the pancreas or uncinate process (fig. 13). Isolated side branch involvement occurs in only about 28% of cases and IPMTs are more frequently multifocal, a major diagnostic feature (fig. 14).

CT and MR are useful to detect intraductal abnormalities. MRP sequences facilitate the evaluation of the pancreatic duct with improved detection of minor side branch involvement and demonstration of the communicating branching ductal pattern (24). This is an important diagnostic feature since other tumors only rarely communicate with the pancreatic duct (fistulization). The multicystic appearance also favors IPMT, along with the presence of mucoid impaction and vegetations. However, it is difficult to confirm the presence of malignant degeneration. The main diagnostic criteria reported in the literature include: presence of a solid mass, dilatation...
of the main pancreatic duct >10 mm, dilata-
tion of a side branch >30 mm with endo-
luminal nodule, diffuse or multifocal in-
volvement, presence of dense or calcified
intraductal material, presence of diabetes,
and presence of a biliary fistula (fig. 15 and
16) (25, 26).

**Cystic endocrine tumors**

Insulinomas, glucagonomas, gastrinomas
and non-functioning endocrine tumors
rarely have a cystic appearance. Endocrine
neoplasms of the pancreas tend to be spo-
radic but may also be associated with ge-
netic diseases (multiple endocrine neoplasia
— MEN type I, VHL) especially when
multiple (22). Cystic endocrine tumors
are more frequent in MEN I patients, up
to 14% of all pancreatic endocrine tumors
(14). The risk of malignancy correlates
with tumor size.
On imaging, these tumors may be entirely cystic or mixed and more heterogeneous with cystic-necrotic component. Cystic tumors are characterized by the presence of focal or circumferential mural thickening, well depicted on CT, that shows intense enhancement after contrast administration (fig. 17). Loco-regional extension of malignant tumors is less extensive than for adenocarcinoma and typically presents as tumor growing into the portal venous system (27). Somatostatin-receptor scintigraphy (OctreoScan) is very useful, in addition to EUS guided biopsy, for diagnosis with sensitivity and specificity values around 80% (22, 27).

Solid pseudopapillary tumor of the pancreas (papillary cystic neoplasm or Frantz tumor)

This is a rare tumor, less aggressive than other pancreatic tumors, corresponding to less than 1% of cystic tumors of the pancreas. This tumor occurs at a mean age of 30 years with strong female predominance. On imaging, this tumor is well defined, usually large (mean size of 11 cm), with hemorrhagic components, and occasional peripheral or central calcifications. After contrast administration, enhancement of the thickened peripheral capsule and solid components surrounding hypodense cystic and necrotic zone is noted (fig. 18). MR is helpful to demonstrate the T2-weighted hypointense peripheral capsule and T1-weighted hyperintense hemorrhagic components (fig. 19) (28).

Diagnostic pitfalls

A few cystic lesions that are extrapancreatic in origin may lead to diagnostic difficulties. Cystic dystrophy of duodenal wall in heterotopic pancreas may be misdia-
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diagnosed as a pseudocyst of the pancreatic head (to the left of the gastroduodenal artery) or duodenum (to the right of the gastroduodenal artery). In cystic dystrophy, CT demonstrates the presence of medial duodenal wall thickening with multiple cysts of variable size at the second stage of the duodenum as opposed to a single cyst without wall thickening in patients with pseudocyst (fig. 20). MRP demonstrates the presence of multiple cysts and associated features of chronic pancreatitis in patients with cystic dystrophy of duodenal wall in heterotopic pancreas.

Exophytic gastrointestinal stromal tumors may have a large cystic necrotic component and may be misdiagnosed as a pancreatic pseudocyst or tumor (endocrine tumor, solid pseudopapillary tumor) (fig. 21). Multiplanar reconstructions should facilitate demonstration of the extra-pancreatic nature of the lesion. Mesenteric and retroperitoneal lymphatics may under certain circumstances, after surgery or in the setting of lymphangiectasias, be dilated and simulate pancreatic pseudocyst. MRP will allow correct diagnosis by demonstrating the communication between collection and lymphatics (fig. 22).

Prognosis of the main cystic lesions

When a lesion remains indeterminate even after comprehensive imaging work-up including CT, MR and EUS, follow-up may be proposed knowing that these lesions have a growth potential.

Several studies on the follow-up of small cystic lesions of the pancreas have been published and provide data about the natural history of these lesions. In the imaging literature, Handrich, et al. (8) have reported that from a series of 22 patients with imaging follow-up of at least 5 years, 13 (59%) patients had a cystic lesion (<2 cm) that remained unchanged or decreased in size whereas 9 (41%) patients had lesions that showed slight interval increase in size without symptoms or pancreatic related death. In the surgical literature, Walsh et al. confirmed these results with a series of 98 patients with indeterminate cystic lesion (mean size of 2.4 cm) of the pancreas after EUS guided aspiration and minimum follow-up of one year where only 4 patients (4%) underwent surgery due to abdominal pain and cyst enlargement; pathology confirmed one serous cystadenoma, one mucinous cystadenoma, one lymphoepithelial cyst and one pseudocyst (29).

Cyst morphologic features that could help predict the presence of malignancy were evaluated. In a retrospective imaging study of 86 patients with cystic lesion of the pancreas ≤3 cm in size (75 benign lesions, 8 borderline malignant lesions and 3 carcinoma in situ lesions), Sahani et al. reported that unilocular and small (≤3 cm) pancreatic cysts were almost never malignant with positive predictive values of 97% and 87% respectively (30). The presence of septa-

Fig. 16: Main ductal IPMT with secondary malignant degeneration. Abdomen CT after injection of contrast showing main ductal dilatation with solid mass. Advanced pancreatic atrophy.

Fig. 17: Cystic endocrine tumor (cystic gastrinoma) of the pancreas. CT showing a rounded lesion with thick hypervascular walls and proximal retention cyst.

Fig. 18: Solid pseudopapillary tumor of the pancreatic body. Abdomen CT after injection of contrast showing a rounded thick walled lesion with solid and cystic components.
In summary, only a small percentage of small (<3 cm) cystic lesions are malignant, follow-up shows that most lesions remain stable, and rounded lesions with thick wall and septations or vegetations should raise concern for a lesion with malignant potential (33, 34).

**Work-up algorithm**

In routine practice, when assessing an incidental asymptomatic cystic lesion of the pancreas, factors to consider include patient life expectancy, surgical risk (morbidity, mortality, and functional sequelae) and natural history of the cystic tumor.

For rounded thin walled simple cysts less than 3 cm in size without septations or enhancement, cyst aspiration for fluid analysis may be considered in younger patients, and follow-up may be considered in elderly patients (1).

Single multilocular cysts (confirmed on MR) less than 3 cm in size, should be considered benign with follow-up MR at 1 year. In cases where the lesion becomes >3 cm or in patients with symptoms, surgery should be considered after EUS guided aspiration and fluid analysis.

For complex rounded cysts less than 3 cm in size or side branch IPMTs >3 cm in size, surgical resection is advisable.
Fig. 22: Retroperitoneal lymphatics in a patient with intestinal lymphangiectasia.

References


