Cystic pancreatic lesions are increasingly identified due to the widespread use of CT and MR. Most of these cysts are incidental findings and are benign or low-grade neoplasms. The characterization and management of these cysts is a dilemma since there is a significant overlap in the morphology of benign and premalignant lesions. MR is the imaging study of choice to both characterize and follow these pancreatic cysts. In many cases these lesions remain undetermined and guidelines are needed for follow up and management.

Introduction

Classification

Pancreatic cysts can be categorized into the following groups:

- **Pseudocysts**
- **Common cystic neoplasms:**
  - IPMN - intraductal papillary mucinous neoplasm
  - SCN - Serous cystic neoplasm
  - MCN - Mucinous cystic neoplasm
- **Uncommon cystic neoplasms:**
  - SPEN (solid pseudopapillary epithelial neoplasm)
  - Tumors with cystic degeneration: adenocarcinoma - neuroendocrine tumor
Systematic Approach

When a cystic pancreatic lesion is detected, the first step is to decide whether the lesion is most likely a pseudocyst or a cystic neoplasm. This scheme is a simplified roadmap for the differentiation of pancreatic cysts.

- **Pseudocyst** - Think pseudocyst when there is a history of pancreatitis, alcohol abuse, stone disease or abdominal trauma and the lesion is unilocular or contains non-enhancing dependent debris.

- **Cystic neoplasm** - Think of the possibility of a cystic neoplasm, when there is no history of pancreatitis or trauma, or when the cyst has internal septa, a solid component, central scar or wall calcification.

- **Mucinous cystic neoplasm** - This is usually a unilocular cyst filled with mucin sometimes with wall calcification, exclusively seen in women.

- **Serous cystic neoplasm** - This is a microcystic lesion, that contains serous fluid with sometimes a characteristic scar which may calcify. It can look like a branch-duct IPMN, but SCN has no communication with the pancreatic duct. The typical appearance makes a specific diagnosis possible, which is important, because SCN is the only tumor that is not premalignant.

- **Branch-duct IPMN** - This tumor can look like a SCN, but has no scar or calcifications. MRCP or heavily weighted T2WI may show the connection to the pancreatic duct, which is highly specific.
MRI is usually of more diagnostic than CT. MRI can show the cystic nature of a pancreatic lesion and its internal structure.

The MRI shows a large cyst with dependent internal debris (figure). Presence of internal dependent debris appears to be a highly specific MR finding for the diagnosis of pancreatic pseudocyst (6).

MRI versus CT

CT will depict most pancreatic lesions, but is sometimes unable to depict the cystic component. MR with heavily weighted T2WI and MRCP will better demonstrate the cystic nature and the internal structure of the cyst and has the advantage of demonstrating the relationship of the cyst to the pancreatic duct as is seen in IPMN.

The images show a serous cystic neoplasm (SCN). MRI better shows the central scar (figure).

There are cases when CT can be helpful, since it better depicts a central calcification in SCN or peripheral calcification in a mucinous cystic neoplasm (MCN).

MRI is usually of more diagnostic than CT. MRI can show the cystic nature of a pancreatic lesion and its internal structure. The MRI shows a large cyst with dependent internal debris (figure).
MRI shows a lesion, which consists of multiple small cysts. This could be a serous cystic neoplasm or a branch-duct IPMN. The connection of the cystic lesion to the pancreatic duct indicates that this is a branch-duct IPMN.

Small pancreatic cysts

How to report

Small pancreatic cysts have been documented in approximately 2.3% of CT studies and up to 19% of MR studies (11). Most of these cysts are found in asymptomatic patients, who are studied for other reasons and represent benign or low-grade indolent neoplasms. The ability of imaging to enable a specific diagnosis of an individual pancreatic cyst is limited, but is easier in larger cystic lesions. In most small cysts we should not attempt to characterize the lesion and when we do, we should not be too confident. The management of cystic neoplasms has not yet been standardized and continues to evolve.

According to the recent 2012 consensus guidelines by Tanaka et al the items mentioned in the Table should be addressed (8).
Management

Age, life-expectancy and comorbidity should be considered in the possible surveillance or treatment. Cysts smaller than 3 cm and no worrisome or high risk-features can be considered for follow-up with either MRI, CT or ultrasound. Cysts with obvious high risk stigmata should be considered for resection.

The table shows the American College of Radiology flowchart for imaging of incidentally discovered pancreatic cysts in asymptomatic patients (11). Pancreatic cysts are regarded symptomatic when there is hyperamylasemia, recent-onset diabetes, severe epigastric pain, weight loss, steatorrhea, or jaundice.

Pseudocyst

key findings:

- Unilocular cyst without solid components, central scar or wall calcification.
- Collection of pancreatic enzymes, blood and necrotic tissue.
- Debris within a cystic lesion is a specific MR finding (6).
- History of pancreatitis or abdominal trauma.
- Cysts develop in 4-6 weeks - usually decrease in size over time - sometimes enlarge or become infected.
- Found in any part of the pancreas or anywhere within the abdomen and sometimes even in the chest.

The CT demonstrates a large cyst in the upper abdomen in a patient who had an acute
Here an example of the value of MRI compared to CT. The MRI shows dependant debris (arrow) as a discriminator for walled off necrosis in a patient with a pseudocyst.

CT demonstrates two large cysts in a 45 year old woman, who had a trauma. Notice some fat stranding in the retroperitoneal space (arrow). The imaging findings combined with the history make it very likely that these are traumatic pseudocysts.

Most pseudocyst occur in the peripancreatic region, but rarely they may extend to the mediastinum.

Scroll through the images. This patient has a chronic pancreatitis. Notice the calcifications in the pancreatic head (curved arrow). There are multiple pseudocysts extending all the way to the mediastinum compressing the heart.

Chronic pancreatitis with pseudocyst extending to the mediastinum

Cystic Neoplasms
The diagnosis of a cystic neoplasm should be considered when there is no history of pancreatitis or trauma.

Morphological characteristics of a cystic neoplasm are: thick irregular rim, septations, solid components, a dilated pancreatic duct > 3mm and calcifications.

Fluid aspirated from a cyst with an amylase level

In the table some discriminating features of cystic neoplasms.
In many cases however it is not possible to make a definitive diagnosis.
It is important to make the diagnosis of a serous cystic neoplasm, since this is the only tumor that has no malignant potential.
In many cases differentiation from a branch-duct IPMN is difficult, since both have multiple small cysts.

**Age and gender**

Some cystic neoplasm are seen almost exclusively in women, like mucinous cystic neoplasm (99%) and serous cystic neoplasm (75%).

Solid pseudopapillary epithelial neoplasm is another pancreatic tumor which may have cystic components.
It is uncommon, but is seen exclusively in young women. Hence the following rule:

- **Grandma** - Serous cystic adenoma
- **Mother** - Mucinous cystic neoplasm
- **Daughter** - Solid pseudopapillary epithelial neoplasm SPEN

**Serous cystic neoplasm**
The pathology specimen shows multiple microcysts, which gives the tumor a lobulated appearance.
A macrocystic serous cystic neoplasm is rare and, although benign, can be similar in appearance to the potentially malignant macrocystic mucinous cystic neoplasm.

**key findings:**

- Benign tumor, but large tumors have a tendency to increase in size and cause symptoms
- Typically seen in 'Grandma'
- Microcystic or honey-combed cyst with central scar (30%) and calcifications (18%)
- Macrocystic in 10% and difficult to differentiate from pseudocyst and mucinous cystic neoplasm
- Lobulated surface
- No communication between cysts and pancreatic duct.
- Hypervascular enhancement is sometimes seen and can look like cystic neuroendocrine tumor
- Growth rate of tumors
  - Growth rate of tumors > 4 cm: up to 20 mm/y

Serous cystic adenomas contain multiple small cysts resulting in a lobulated contour. Some have a central scar with calcifications.

The pathology specimen shows multiple microcysts, which gives the tumor a lobulated appearance.

A characteristic feature of a serous cystic neoplasm is a central scar, sometimes with calcifications.
Sometimes the microcystic component of this tumor is difficult to identify on CT.
MR will better identify the internal architecture.
MRI is also useful in determining if the cysts communicate with the pancreatic duct or not to differentiate this lesion from a branch-duct IPMN (see below).

The pathology specimen shows a cystic tumor with multiple small cysts and a central scar.
There are no calcifications.
CT-image of a 51 year old woman with a history of gallstones and abdominal pain. There is a hypodense lesion with central calcification in the head of the pancreas. The lesion has a lobulated contour. Continue with the MR.

MRI better demonstrates the morphologic features of the lesion. On T2WI the lesion is multicystic. Note the central low signal due to the central scar with calcifications. Although some of the cysts are rather large, this is still a characteristic appearance of a serous cystic adenoma.

Another example of a serous cystic neoplasm. The enhanced image on the right shows a hypodense lesion with central calcification in the body of the pancreas. On the right image subtle enhancement of septations are seen. Notice that on CT it is very difficult to appreciate the cystic nature of these lesions and you might think that you are dealing with a pancreatic adenocarcinoma.

MRI will easily demonstrate the cystic nature of these lesions. The T2WI with fatsat nicely demonstrates a lobulated hyperintense lesion with central scar, which is characteristic of a SCN.
Another example of a serous cystadenoma. Notice the central enhancement. Sometimes differentiation from a hypervascular cystic neuroendocrine tumor can be difficult, but in this case the central calcifications are helpful.

T2WI of a 71 year old man with a history of weight loss and nondescript upper abdominal complaints. This was initially thought to be a branch-duct IPMN, but turned out to be a SCN. Notice the central hypointensity. This is scar tissue in a SCN. Notice also the characteristic lobulated surface.

It may be difficult to differentiate a serous microcystic adenoma from a branch-duct IPMN or intraductal papillary mucinous neoplasm. IPMN is always connected to the pancreatic duct.

Courtesy Koenraad Mortel, Dept Radiology, Brigham and Women's hospital, Boston
Scroll through the images.

In the pancreatic tail is a cystic lesion with a central scar with calcifications (arrow). Eventhough some of the cyst are larger than 2 cm, this presentation still is typical for a serous cystic neoplasm, because of the central scar, multilocular appearance and the lobulated contour.

This patient had abdominal complaints which were attributed to the tumor, which was resected and proved to be a serous cystic neoplasm.

This is the resected specimen. The tumor was attached to the spleen, which also had to be resected.

Another case of a typical serous cystic neoplasm. There is a microcystic lesion with a central scar in the pancreatic head. This patient felt a mass in her abdomen. Otherwise there were no complaints. Because resection would mean extensive surgery, it was decided to follow the lesion. During 5 year follow up there was no growth and the patient has no symptoms otherwise.

**Mucinous Cystic Neoplasma**
**key findings:**
- Premalignant tumor - may transform into a mucinous cystadenocarcinoma
- *Exclusively seen in women* - Typically in 'Mother' - median age: 40-50 years
- Macrocystic with thick wall septations and peripheral calcifications
- Peripheral calcifications seen in 25%. This finding allows you to make a specific diagnosis
- Location in the tail and body of the pancreas (95%).
- Most are symptomatic, presenting with nondescript abdominal pain

CT-images of a 32 year-old female with pain in the upper left quadrant radiating to the back. There is a large cyst in the pancreatic tail with peripheral calcification. There is subtle septation as seen on the left image and wall thickening. You may have to enlarge the image to see the septation. A specific diagnosis of a MCN can be made.

### Intraductal Papillary Mucinous Neoplasm

**key findings:**
- Mucine producing tumor in main pancreatic duct or branch-duct.
- Location: pancreatic head >> tail and corpus.
- Must have communication with pancreatic duct. Best seen with MRCP.
- Can be multifocal.
- Main-duct IPMN has imaging features distinct from branch-type.
- Branch-duct type can look like other cystic neoplasms

Macroscopic specimen of a IPMN showing mucinous tumor, with extensive mucin producing papilary neoplasm (arrow).
Main-duct IPMN

On imaging Main-duct IPMN is distinct from branch-duct IPMN, but sometimes there is a mixed type.

Scroll through the images of a large main duct and branch-duct IPMN. There is obstruction of the common bile duct with dilatation of the intrahepatic bile ducts (blue arrows). Notice the extremely widened main pancreatic duct (red arrow).

Normal T2WI and heavily T2WI with fatsat of a large main duct IPMN with extremely dilated pancreatic duct.

This patient presented with pancreatitis. The MRCP shows both a main-duct as well as a branch-duct IPMN (arrow). IPMN is a lesion with malignant potential.

Signs of malignancy are:

- Pancreatic duct > 8 mm - as in this case.
- Solid node in duct.
- Mass around the pancreatic duct.
- Enlarged choledochal duct.

CT-images of an IPMN with a dilated pancreatic duct (blue arrows). Notice enhancing solid nodule in the pancreatic head (red arrow). Continue with US-image.
The US-image shows a large branch-duct component within the pancreatic head.

Branch-duct IPMN

The CT-image shows a hypodense lesion in the pancreatic head. This could be an adenocarcinoma, but the low density makes you think of a cystic tumor. The microcystic appearance raises the possibility of a serous cystic neoplasm although there is no calcified scar. On MRCP the cystic nature is better appreciated and there is a connection to a widened duct (blue arrow).

A detail nicely demonstrates that some of the mucus-filled branches are seen in cross-section and some longitudinally.

In a 73 year old male a hypoechoic lesion was found in the pancreatic body, that looked like a cystic lesion. CT also identifies the lesion but isn't of much help.

The heavily T2WI nicely demonstrates the multicystic lesion with the connection to the pancreatic duct, i.e. a branch-duct IPMN.
CT-images of a patient with a branch-duct IPMN who choose not to have surgery. Over time growth of the tumor is seen with dilatation of the main duct indicating malignant transformation. Sometimes it takes 5-8 years before a transformation is seen.

Uncommon Neoplasms with specific findings

Solid Pseudopapillary Neoplasm

*key findings:*
- Very uncommon neoplasm seen in women 20-30 years (*Daughter*).
- Solid and cystic neoplasm with capsule and with early 'hemangioma-like' enhancement. Sometimes intratumoral hemorrhage

CT-images of a 26 year old woman with a large mass in the pancreatic head and metastases in the liver. In the center there is lack of enhancement due to cystic or necrotic degeneration.

Neuroendocrine tumor with cystic degeneration

*key findings:*
- Non-functioning endocrine neoplasm
- Also called islet cell tumor
- Hypervascular with ring-enhancement. This is unlike serous cystic neoplasms that enhance from the center and more solid)
CT-images of a 61 year old woman with weight loss. There is a large mass in the body of the pancreas that is hypervascular, unlike an adenocarcinoma, with some cystic or necrotic parts.

CT-image of a neuroendocrine tumor with central necrosis. Sometimes this can simulate a cystic component. Notice the peripheral enhancement.

Neuroendocrine tumor with central necrosis

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