Advanced Diagnostic Imaging of Pancreatic Cysts by Multidetector Computed Tomography

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ABSTRACT

Nowadays, increasing use of cross sectional imaging especially multi-detector computed tomography causes greater detection of pancreatic cysts. The differentiation between pancreatic pseudocyst and cystic pancreatic neoplasm is essential in determining the proper treatment and prognosis. Typical imaging findings of benign pancreatic cystic lesion, especially in the asymptomatic patient, can be refined through imaging follow up. Fast scanning time and the thin slice of multidetector computed tomography provides a high resolution of image quality, less motion artifact and multi-planar reformation. It is a non invasive technique and entails few complications. However, in an atypical imaging pattern or if suggestive of malignant in nature, further investigation with endoscopic retrograde cholangiopancreatography (ERCP) with fine needle aspiration (FNA) for tissue diagnosis or cytology can aid in definite diagnosis.

Keywords: Pancreatic pseudocyst, pancreatic cystic neoplasms, multi-detector computed tomography

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Pancreatic cysts can be true cyst, pseudocyst or cystic tumor. Pancreatic pseudocyst of up to 75% is most commonly found in this group. Pancreatic cystic tumor is relatively rare, found in only 10-15% of pancreatic cystic lesions and only 1% of all pancreatic neoplasms. The cell origin of this tumor can be divided in 5 subgroups: epithelial origin, exocrine origin, unknown/mixed origin, endocrine and mesenchymal origin. Multi-detector computed tomography (MDCT) imaging can provide better detection and more accurate diagnosis of these clinical entities due to its advanced technical development, increasing use of thin slice, high resolution, fast scan and multiplanar reformation. The imaging can be used in asymptomatic patients, as well as in patients presenting with abdominal pain, obstructive jaundice or pancreatitis. Characterization from cross-sectional imaging by using morphologic appearance is helpful for diagnosis, prognosis and proper further treatment in these patients. Although many types of cystic pancreatic neoplasm have been reported, serous cystadenoma, mucinous cystic neoplasm and intraductal papillary mucinous neoplasms (IPMNs) comprised of 90% of all primary cystic pancreatic neoplasms. Benign pancreatic cystic lesions include pancreatic pseudocyst, serous cystadenoma and benign IPMN. Premalignant and malignant pancreatic cystic tumors include mucinous cystic tumor, solid pseudopapillary epithelial neoplasms of pancreas (SPENs) and malignant IPMNs, and these are recommended for surgical treatment. Currently, imaging study combined with serum tumor marker and endoscopic retrograde cholangiopancreatography (ERCP) findings are used for diagnosis of pancreatic cystic lesions. The aim of this article is to characterize CT imaging findings in each common pancreatic cystic lesion.

Technique

Pancreatic tumor protocol is performed in non contrast, pancreatic phase and venous phase with the following scanning parameters: collimation, 16 x 0.75 mm; table feed/rotation, 9 mm; slice width, 0.75 mm; volume pitch, 16; 120 kVp; and 250 mAs. Calcification or hemorrhage in pancreas is clearly recognized in non contrast study. At the beginning of the contrast-enhanced CT scan, 100 ml of nonionic iodinated contrast material is injected IV through a 20-gauge canula at 3 ml/sec using an automated power injector. The pancreatic phase is acquired in the late arterial phase, at 40 sec. Hypovascular pancreatic tumor or cyst can be demonstrated clearly on this phase in contrast to maximal enhancement of pancreatic parenchyma. The delay between the start of contrast administration and the start of helical scanning was approximately 70-80 seconds to achieve the venous phase. Images were obtained from the hepatic dome to the iliac crest during a single
breath-hold. Images were reconstructed at 1.25 mm intervals with a soft-tissue algorithm. Water is preferred for stomach distension and small bowel loop distension than diluted water soluble iodinated contrast in this protocol. \(^7\)

**Pancreatic pseudocyst**

Pancreatic pseudocyst is defined as a localized amylase-rich fluid collection located within or adjacent to the pancreas, surrounded by fibrous or granulated tissue that does not share a lining with the epithelium\(^5\) and has no associated tissue necrosis within the collection. It develops during a period of 4-6 weeks after onset of acute pancreatitis. It can occur in association with chronic pancreatitis as chronic pseudocysts or acute exacerbation of pancreatitis on top of chronic pancreatitis. Fluid content usually has increased amylase and lipase levels, indicative of ongoing communication with the pancreatic ductal system. MDCT scan can identify the presence of ductal communication in some cases (Fig 1B). This finding is helpful in aiding differentiation from the unilocular pattern of mucinous cystic tumor. Typically, imaging findings of a pseudocyst on CT is a well defined unilocular homogeneous fluid contained in a cystic lesion with a smooth thin rim enhancing wall\(^7\) (Fig 1A). No enhancing mural solid nodule or internal septation in this lesion is observed. Imaging findings of chronic pancreatitis included dilatation of the main pancreatic duct, pancreatic parenchymal atrophy, intraductal calcification and parenchyma are other associated features that can be found with a pseudocyst.\(^6\) Internal layering of a fluid-fluid level due to internal debris is found in some cases which are helpful in differentiating from mucinous cystic tumor. (Fig 1C, D) Delayed enhancement of the wall can be demonstrated due to its fibrous component. (Fig 1D)

A unilocular cyst of a pancreas in a patient with recent clinical history of acute pancreatitis is almost always a pseudocyst. A pancreatic pseudocyst without a preceding episode of acute pancreatitis is a diagnostic problem. Incidental pancreatic cysts are usually smaller than symptomatic cysts and occur in older patients.\(^9\) (Fig 1E, F) A mucinous cystic tumour should be considered in the differential diagnosis. In this group of patients, endoscopic ultrasound-guided aspiration or biopsy, or at least a follow-up study, should be recommended. With a pseudocyst smaller than 6 cm, in diameter or an asymptomatic patient with a prior history of acute pancreatitis, conservative treatment can be provided because it can resolve spontaneously.\(^7\)

**Serous cystadenomas**

Serous cystadenomas or microcystic cystadenoma is usually found in women over the age of 60 years with non specific abdominal pain or incidental findings. It was mostly found at the head region and has three morphologic patterns: polycystic, honeycomb, and oligocystic patterns.\(^10\) Polycystic patterns are most commonly found, in up to 70% of cases. This pattern has usually more than 6 cysts and microcysts less than 2 cm each with fine lobulation of the surface.\(^8\) Calcified fibrous central scar was seen on CT or MRI in 30% of cases which are highly specific and pathognomonic for serous cystadenoma\(^11\) (Fig 2A-D). Delayed enhancement may be observed in the central scar due to a component of fibrosis.\(^11\) A honeycomb pattern or spongy lesion (about 20%) is composed of innumerable microcysts with soft tissue or of mixed density and sharp interface. The non contrast phase tumor has a lobulated margin and homogeneous hypodensity. The maximal enhancement of septa is demonstrated in the arterial phase and is isodense to pancreatic parenchyma in the portal venous phase. A tumor may appear as a solid mass in all phases, depending on the size of cyst and amount of fibrous tissue.\(^7\) (Fig 2E-G) Oligocystic (or macrocystic) pattern is a very uncommon pattern (less than 10%) and is difficult to differentially diagnose from mucinous cystic tumor (Fig 2H, I) and the branch duct type of intraductal papillary mucinous neoplasms. Imaging findings that are more specific for macrocystic serous cystadenoma than mucinous cystic tumour are at the pancreatic head location, lobulated contour and lack of wall enhancement.\(^11\) Shah et al.\(^12\) suggested that the combination of microcystic appearance and surface lobulations offers accuracy comparable to a central scar with higher sensitivity. In addition, cyst-duct communication and pancreatic duct dilatations are suggestive of
a intraductal papillary mucinous neoplasm. Serous cystadenoma can be multiple unilocular cysts in von Hippel-Lindau (VHL) disease which usually indicates diffuse involvement of the pancreas. This disseminated variant is rare. Pancreatic involvement in VHL disease may form simple pancreatic cysts (50-91%), serous cystadenoma (12%), neuroendocrine tumor (5-17%) and rarely adenocarcinoma. Cysts in the liver or kidneys may be depicted in VHL disease. Atypical manifestations of serous cystadenoma include giant tumors with ductal dilatation, intratumoral hemorrhages and solid variants. Unilocular cystic tumors, interval growth, and a disseminated form are also described in the literature. In this group for which uncertainty of diagnosis is based on cross-sectional imaging, further evaluation by endoscopic sonography and fine needle aspiration is suggested. Tumor markers from fluid aspirate are helpful for diagnosis cystic lesion of pancreas. In serous cystadenoma, tumor markers, including CEA, CA 72-4, CA15-3 and amylase, are at a low level. Due to the benign nature of disease, follow up imaging in asymptomatic patients is recommended. However, if the patient has a large lesion with symptoms, surgical excision is advised.

Mucinous cystic neoplasm

Mucinous cystadenomas are the most frequent cystic tumors of the pancreas and comprise approximately 50% of all cystic tumors. Almost all mucinous cystic neoplasms occur in women with an age range of 40-60 years. It’s commonly found in the body and tail of the pancreas as a solitary lesion with a size range of 6-35 cm. It has macrocystic pattern with locules less than 6 cysts, more than 2 cm in each. The cyst wall is lined by mucin-producing columnar cells filled with mucus, hemorrhage and debris. The tumors are classified by histology as benign, borderline, or malignant based on the degree of dysplastic changes. This classification is well correlated with the prognosis and suggests that all these tumors be treated as potentially malignant. Mucinous cystic neoplasms may be unilocular (Fig 3B, C) or multilocular (Fig 3A, D). Peripheral rim calcification, may be seen in a laminated pattern, in about 10-25% of patients (Fig 3A) in contrast to central calcification, which is commonly found in serous cystadenoma. Thickened enhancing wall, the presence of papillary proliferations, vascular involvement and a hypervascular pattern on post contrast study are suggestive of malignant change. An enhancing intramural nodule is usually demonstrated in the pancreatic phase. Non enhancement of high density content in some loculations in the tumor represents debris or hemorrhage. Due to the presence of fibrous tissue within the tumor wall, delayed enhancement may be observed in the venous phase. A large tumor may displace adjacent organs and compress the splenic vein, resulting from mass effect rather than direct tumor invasion. Thin wall unilocular pattern cannot be differentiated from other cystic masses of the pancreas based on imaging finding alone. Fine needle aspiration in this group is necessary. Tumor markers from fluid aspirate of mucinous cystic neoplasm included CEA, CA72-4 and CA15-3 which are usually rising. Mucinous cystic neoplasms are considered premalignant lesions. Therefore, excision is the treatment of choice especially for fit patients.

Intraductal papillary mucinous neoplasms (IPMNs)

Intraductal papillary mucinous neoplasms (IPMNs) are a ductal type of mucinous pancreatic tumor. This tumor growth from hyperplasm of mucin-producing columnar epithelial cells lining the pancreatic duct which subsequently show dysplastic proliferation and papillary projections protruding into the duct. It is observed more commonly in men between 70-80 years and often occurs in the pancreatic head location. Small intraductal tumors are typically identified incidentally during cross-sectional imaging performed for other indications or in the asymptomatic patient. In larger tumors, preceding symptoms may mimic those of chronic pancreatitis, particularly epigastric pain occasionally radiating to the back. Other signs and symptoms of advanced disease include abdominal mass, diarrhea, diabetes, and weight loss. Histologically, the lesions can represent a spectrum of abnormalities from simple hyperplasia to papillary adenoma and carcinoma. Gradual distension of the branched and main pancreatic duct is caused by hypersecretion of mucin content. This mechanism induces impaired outflow of pancreatic secretion and consequently produces symptoms of
pancreatitis. Endoscopic study demonstrates protruding mucin content from bulging patulous duodenal papilla.26 IPMNs can be divided in 3 subtypes: branched duct type, main duct type and combined type.

First, the branch duct type of IPMN usually occurs at the uncinate process of the pancreas.27 It may be growing as cluster of small cysts (Fig 4A, B), internal septa with lobulated margin or have a unilocular cystic appearance. MDCT can demonstrate cyst-duct communication. Marked dilatation of the main pancreatic duct is often an associated finding due to mucin content produced from the tumor. The intraductal mass is frequently not seen because the tumor is flat. Second, the main duct type is diffuse or focal dilatation of the main pancreatic duct. Third, in the combined type both branched ducts and the main pancreatic ducts are involved. Bulging duodenal papilla, enhancement of a ductal nodule and severe dilatation of the main pancreatic duct are more frequent in the malignant form.28,29 However, it is difficult to differentiate diffuse involvement of the pancreatic duct in IPMNs from simple dilatation due to the obstructions and duct dilatation in chronic pancreatitis. Presence of mural nodules (Fig 4C, E) or intraductual mucin and herniation of the papilla into the duodenal lumen helps differentiate IPMT from chronic pancreatitis.21 Sometime, solid cystic appearance with heterogeneous enhancement is observed as a malignant transformation of IPMN which could be differentiated from solid pseudopapillary neoplasm or neuroendocrine tumor (Fig 5C, D). Tumor markers from aspirated fluid show rising CEA, CA 72-4 in this tumor.30 According to these, the imaging appearance is (1) less than 2.5 cm in diameter, (2) confined to the branched ducts, or (3) displays no solid components. Conservative treatment with serial image follow-up is considered because most lesions are usually benign and exhibit very slow growth.3 Total resection is the treatment of choice for the main duct type. Local resection is often sufficient for the main duct type with segmental involvement.7

### Solid pseudopapillary neoplasms (SPNs)

Solid-pseudopapillary neoplasms (SPNs) are rare pancreatic neoplasms. About 1% of pancreatic neoplasms exhibit low malignant potential.20 It most frequently affects young women, with a mean age about 30 years, and is usually a large size at presentation. Other names of SPNs include solid and cystic tumor, solid and papillary epithelial neoplasm, papillary-cystic neoplasm, papillary cystic epithelial neoplasm, papillary-cystic tumor, and Franz tumor.31 Most SPNs are silent neoplasms, confined to the pancreas in 85% of patients, and even the 10 to 15% of patients with liver or peritoneal metastases.32 The malignant pancreatic tumors often affect older men.33 Tumor mass may occur anywhere in the pancreas and is usually large at the time of diagnosis. MDCT demonstrates a well defined lesion with varying cystic and solid components.34 The solid portion shows hypo- or iso- attenuation on pre-contrast CT, slightly enhanced in the arterial phase and with progressive enhancement in the portal phase. The cystic portion shows hypo-attenuation in all phases without significant enhancement (Fig 5A). The cystic space is usually more centrally located, representing tumoral necrosis, hemorrhage or cystic change.31 No duct-tumor communication is observed. Calcification may be present with a chunky appearance. Some tumors have

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cystic dominance with internal septation and small internal solid mural nodules (Fig 5B) which could aid differential diagnosis compared with other pancreatic cystic tumor such as mucinous cystic neoplasm. In this atypical case, fine-needle aspiration biopsy and cytologic analysis or excisional biopsy and histologic analysis are needed for definitive diagnosis. Tumor marker and amylase are not rising.

In conclusion, MDCT is a useful non invasive technique to assist in charactering pancreatic cystic lesions and the adjacent structure. Acquisition of thin section data, fast scan and multiplanar reconstruction of MDCT result in a significant improvement over the old single slice technique as well as better delineation of structural finding and diagnosis.

REFERENCES


