

Review Article

Multidetector CT findings of pancreatic neoplasms with histopathological correlation: a pictorial essay

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ABSTRACT

Pancreatic neoplasms are one of the leading cause of death in the world. Multidetector computed tomography (MDCT) provides high resolution images and is useful in the detection and staging of pancreatic malignancies. The acquisition of images in arterial, venous and delayed phases improves the accuracy of diagnosing unresectable pancreatic carcinoma and also helps in identifying indirect signs of a mass with no visible pancreatic contrast in the form of atrophic distal parenchyma, interrupted duct sign and mass effect. This pictorial essay aims to depict characteristic appearance of various pancreatic neoplasms on 64 slice MDCT and their corresponding histopathological appearances.

Keywords: Pancreatic tumours, Cystic pancreatic tumours, Multidetector computed tomography

INTRODUCTION

Pancreatic neoplasms are one of the most leading cause of death in developing countries and stands fourth in overall cancer deaths.¹ Dual phase multi detector computed tomography in arterial and portal venous phases using single breath-hold with superior contrast bolus utilization for evaluating pancreatic neoplasms have become an important modality of choice.²

With incorporation of multiplanar three-dimensional reconstruction techniques like volume rendering, maximum intensity projection along with surface shaded display provides comprehensive information about the relationships, extent and possible involvement of vascular structures of pancreatic neoplasms. The other advantages are reduced scan time, thin slice acquisition and good resolution.

IMAGING TECHNIQUE

In our institution, the pancreatic imaging protocol consists of an unenhanced scan performed after administering 500 ml of water orally 20 minutes before the examination and another 250 ml given just prior to the start of the scan to improve detection of pancreatic abnormalities by causing adequate distension of stomach and duodenum. This is followed by contrast study in arterial phase (With 5 sec delay after the bolus tracking is triggered) and venous phases (With 25 sec delay after the bolus tracking is triggered). The region of interest (ROI) cursor for bolus tracking is placed in the aorta at the level of diagram. The images are obtained from a 64 slice scanner, light speed VCT system (GE Healthcare). Non-ionic iodinated contrast medium, iohexol 300 mg (Omnipaque) is administered intravenously by a pressure injector with a dose of 1.5 ml per kg at rate of 4 ml per sec. The normal pancreas enhances well in the arterial

phase whereas most of the non-endocrine pancreatic tumours enhance poorly thus providing a good contrast between the tumour and normal pancreas.³ The portal venous phase is useful in studying peripancreatic tissue involvement, duct dilatation and distant metastases.³ Multiplanar three-dimensional reconstruction techniques like volume rendering, maximum intensity projection are done to gather information about the relationship, extent and possible involvement of vascular structures. Minimum intensity projection images are also obtained to get more information about doubtful cysts and their relationship with the ductal system.

DISCUSSION

Appearance of pancreatic tumours on MDCT

Ductal adenocarcinoma

Pancreatic ductal adenocarcinoma is the 13th most common cause of cancer, 8th most common cause of cancer mortality in the world and accounts for 90% of all pancreatic neoplasms.² It has a low survival rate approximating 5-year with majority (78%) occurring in the pancreatic head.⁴ On CT it commonly appears hypodense (Figure 1A), although it may be isodense to pancreatic parenchyma and appears hypoenhancing (Figure 1B, 1C) with respect to the surrounding normal parenchyma on contrast administration, aiding detection of small and subtle tumours (Table1). Tumour margins are best defined on the arterial phase, in which the tumour shows relatively poor enhancement in comparison to normal pancreatic parenchyma.⁵

Cystic neoplasms

In recent times, cross sectional imaging techniques increased the detection of cystic lesions of pancreas along with surgical resection specificity. MDCT with minimal slice thickness has become the preferred imaging modality for both initial detection and characterization of pancreatic cysts, however MRCP has the advantage of demonstrating the relationship of the cyst to the pancreatic duct accurately. Endoscopic ultrasonography (US) provides high-resolution about the morphologic information, as well as guiding cyst fluid aspiration and biopsy from suspicious areas.⁶

Cystic pancreatic tumors represent approximately 10% of all pancreatic neoplasms with 1% showing malignant potential.^{7,8} They are classified as serous cystic neoplasms and mucinous cystic neoplasms. Various histologic types of cystic neoplasms have been reported of which 90% of all primary cystic pancreatic neoplasms consist of serous cystadenomas, mucinous cystic neoplasms, and Intraductal Papillary Mucinous Neoplasms (IPMNs).⁶

Differentiating the serous neoplasms [Microcystic adenomas (SMAs) and Serous Oligocystic Adenoma (SOAs)] from most mucin-producing lesions (IPMNs, mucinous cystic neoplasms) is important. Serous cystadenomas are usually benign tumours and rarely require surgical excision, whereas mucinous tumours require surgery due to their malignant potential. Table 2 summarises the clinical and imaging features of cystic pancreatic tumors.

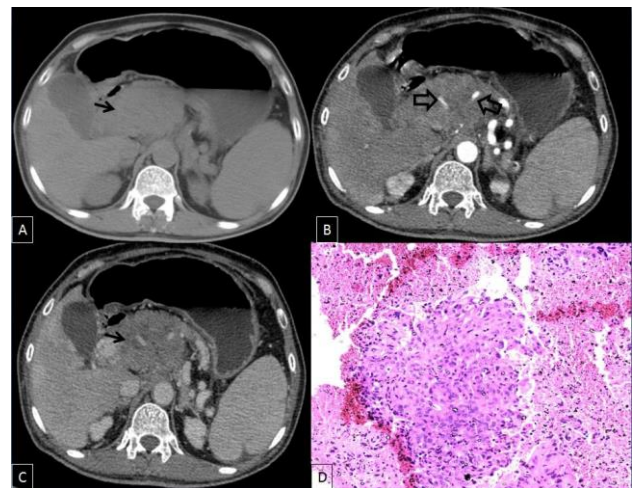


Figure 1: Axial unenhanced (A), enhanced sections in arterial (B) and venous (C) phases show a poorly enhancing lesion with necrotic areas in the head and proximal body (arrow). There is encasement of the branches of superior mesenteric artery (open arrow). Histopathological section from biopsy (D) shows features of poorly differentiated carcinoma (H & E x100). In view of the vascular invasion, the patient was not operated and underwent chemotherapy.

Table 1: Solid pancreatic tumours.

Tumour	Age (years)	Sex-preponderance	Contrast enhancement	Cystic component
Adenocarcinoma	>60	Male	Minimal (Early arterial)	-Usually absent -Rarely seen in case of degeneration
SPN	<35	Female	Nil/late	Seen
NEN	>35	Male	Early	Not seen

Table 2: Cystic pancreatic tumours.

Tumour	Age (years)	Sex-preponderance	Connection to pancreatic duct	Cyst size	Wall thickness	Internal Septations	MPD thickening	Calcification	Contrast enhancement
SMA	>60	Female	No	Micro	<2 mm	Yes	No	Yes	Yes
SOA	40-50	Male	No	Macro	>2 mm	Yes	No	Yes	Yes
MCN	40-60	Female	No	Macro	>2 mm	Yes	No	Yes	Yes
IPMN	>60	Male	Yes	Variable	NIL	No	Yes	No	No

Microcystic adenomas (SMAs), Serous oligocystic adenoma (SOAs), Mucinous cystic neoplasms (MCN), Intraductal papillary mucinous neoplasms (IPMN)

Serous cystic neoplasms

The serous cystic neoplasms are further classified as microcystic and macrocystic depending on the size of the cyst.

Microcystic serous neoplasms: Microcystic serous tumours are benign tumours with low malignant potential and show strong female predilection occurring commonly after 60 years.^{9,10}

Hence, the term “grandmother” lesion has been coined to describe this tumor. They are more common in the head of the pancreas and vary in size from 2 to 25 cm in the longest dimension.¹¹

On CT they appear as lobulated hypodense masses showing less than 2 cm cysts with central stellate scar and calcification (Figure 2A).

After contrast administration, in 70 % of cases, enhancement of the septations are seen giving a honeycomb appearance due to the presence of tiny cysts usually more than six (Figure 2B, 2C).

In the remaining 30% of cases, imaging show fibrous central scar with or without a typical characteristic stellate pattern of calcification which is pathognomonic for serous cystadenoma. In case of indeterminate CT findings, further characterization with MRI and endoscopic US is helpful. At MR imaging, the microcysts are seen as numerous T2 hyperintense foci. On endoscopic US, they are seen as small discrete anechoic areas increasing the specificity of diagnosis.⁶

Macrocytic serous neoplasms: Macrocytic serous neoplasms are mostly benign and extremely rare. They present with cysts larger than 2 cm size and sometimes resemble mucinous cystadenoma.¹²

The cystic tumours in this category include mucinous cystic neoplasms and Intraductal papillary mucinous tumours (IPMNs).

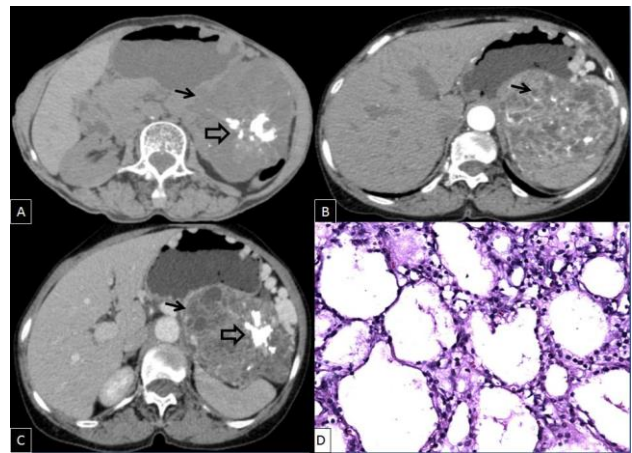


Figure 2: Axial unenhanced (A), enhanced sections in arterial (B) and venous (C) phases show a lesion with multiple cysts less than 2 cm (arrow). Central stellate calcification seen (Open arrow). There is septal and wall enhancement seen. Histopathological section (D) shows microcystic spaces lined by low cuboidal benign epithelium suggestive of microcystic serous cystadenoma (H & E x100).

Mucinous cystic neoplasm

Mucinous cystic neoplasms have a strong female predilection and are most often located in the body or tail of the pancreas. These tumours have higher malignant potential,¹² occurring more frequently in women who are in their fourth to sixth decades. The term “mother” lesion has been used due to the age and gender tendencies of this tumor.¹² They reveal cysts that are less numerous and larger in size (average diameter - 12 cm). They show a smooth external surface and are composed of large uni/multilocular (>2-4 cm) cysts with thicker wall. On CT, they appear as smooth, round or ovoid near-water-density cystic lesion showing amorphous calcification, septations (thin, straight or curvilinear) and solid components (Figure 3A, B, C). After contrast administration enhancement of cystic wall and septations are seen.

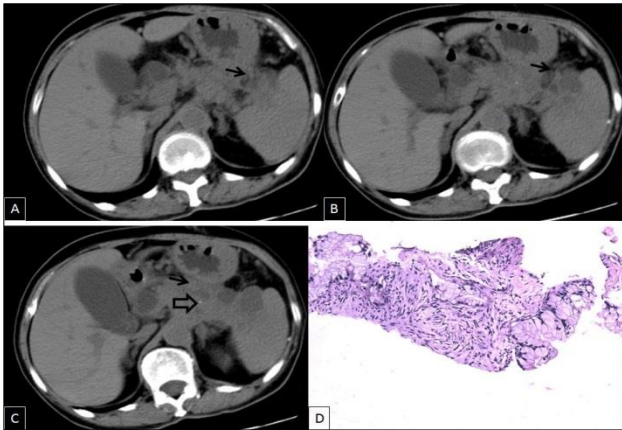


Figure 3: Axial unenhanced sections (A, B, C) show a lesion with multiple cysts greater than 2 cm size (arrow) with punctate calcification (Open arrow) in the body and tail region. Histopathological section (D) shows benign tumour lined by tall columnar cells with intracytoplasmic mucin-suggestive of mucinous cystadenoma (H & E x400). Contrast administration was deferred as the patient had elevated renal parameters.

Intraductal papillary mucinous tumour

Intraductal Papillary Mucinous Tumour (IPMT) is the preferred term to describe a spectrum of proliferation of the pancreatic ductal epithelium with production of excessive amounts of mucin and progressive dilatation of the main pancreatic duct or cystic dilatation of the branch ducts.¹⁴ IPMT has increased prevalence in men older than 60 years (grandfather lesion). It is characterized by the presence of cystic dilatation of the main duct (main duct type) or branches of the pancreatic duct (branch duct type) and sometimes a combination of both (mixed type). Diffuse types are characterised by diffuse hypodensity of the pancreas. It may be associated with parenchymal atrophy especially in more advanced cases. Pathologically they may show hyperplasia (adenoma), carcinoma *in situ* or invasive carcinoma. The radiological features include cystic or solid (papillary) lesion (Figure 5A, 5B, 5C), related to a pancreatic duct and cystic lesions may show malignant features like mural nodule, irregularity of the wall and thick septae. Multiplanar reconstructions are extremely useful to delineate the tumour from the dilated ducts. Currently MRCP is the modality of choice in establishing the communication between the cystic lesion and the pancreatic duct and evaluating the extent of pancreatic ductal dilatation reliably.

Cysts with a solid component

Cysts with a solid component may be true cystic tumours (mucinous cystic neoplasms, IPMNs) or solid pancreatic neoplasms with associated cystic component (islet cell tumor, solid pseudopapillary tumour, adenocarcinoma and metastasis). MR imaging with MRCP is more

sensitive than CT in the detection of small mural nodules.⁶

Solid pseudopapillary neoplasm

It is a rare cystic neoplasm of pancreas accounting for 1-2% of exocrine pancreatic tumour. It has a low malignant potential and a favorable prognosis and is generally treated with surgical excision.¹³ These tumors mainly occur in women in their second to fourth decades. Thus, the term “daughter” has been coined to describe this type of tumor.¹² On CT it is seen as a well-encapsulated lesion with varying solid, cystic and calcific components with hemorrhagic degeneration giving a heterogeneous appearance (Figure 4A). Following contrast administration it may show peripheral enhancing areas (Figure 4B, 4C) (Table1).

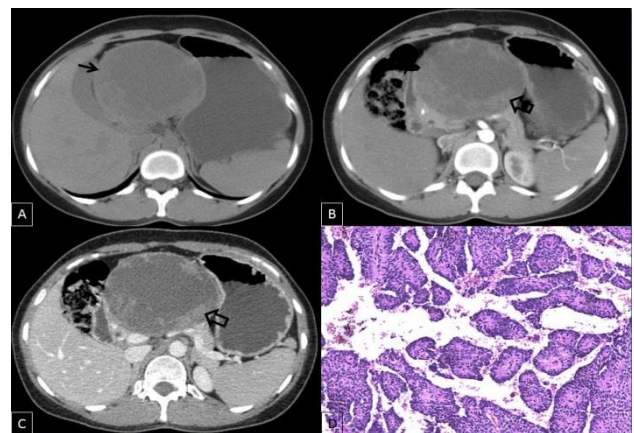


Figure 4: Axial unenhanced (A), enhanced sections in arterial (B) and venous (C) phases show a large well encapsulated mass in the neck and proximal body of pancreas (arrow). Heterogeneous and peripheral enhancement is seen in the enhanced scans. (Open arrow). Histopathological section (D) shows benign appearing tumour cells in pseudopapillae suggestive of solid pseudopapillary neoplasm (H & E x100).

Lymphoma

Primary pancreatic lymphoma is uncommon and it is usually Non-Hodgkin’s B cell lymphoma.¹⁴ It can be focal or diffuse (Figure 6A, 6B) and usually presents with peripancreatic and retroperitoneal lymphadenopathy (Figure 6A) with lesions within the spleen, liver and kidney (Figure 6C). Peripancreatic lymphadenopathy can be differentiated from primary pancreatic lymphoma by the presence of intact fat planes between the nodes and pancreas with anterior displacement of the pancreas. Diffuse variety can be differentiated from pancreatitis by the clinical history. The enlarged pancreas appears homogeneous and hypodense on unenhanced CT without ductal obstruction. They enhance poorly following contrast (Figure 6B) administration. The focal variety is differentiated from adenocarcinoma by the lack of ductal dilatation.

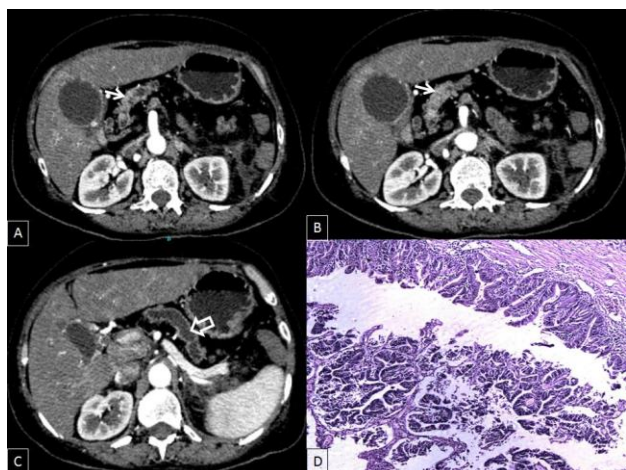


Figure 5: Axial enhanced sections in arterial phase (A, B, C) show a solid lesion with papillary projections in the neck region related to the main pancreatic duct (arrow) with main pancreatic duct dilatation (open arrow). Histopathological section (D) shows features of main duct intraductal papillary neoplasm with high grade dysplasia - Carcinoma *in situ* (H & E x100).

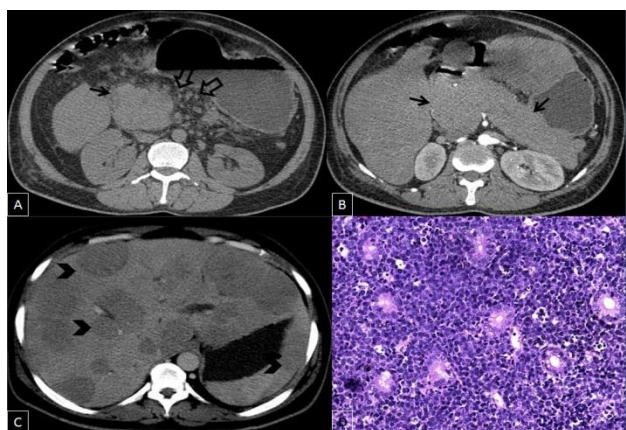


Figure 6: Axial unenhanced sections (A) show a mass lesion involving the pancreas (arrow) and multiple peripancreatic lymph nodes (open arrow). Axial section in arterial phase (B) shows diffuse involvement of pancreas with poor enhancement (arrow). Axial section in venous phase (C) shows multiple hypodense lesions in the liver and spleen (arrow head). Histopathological section (D) shows neoplastic small blue cells infiltrating the adjacent duodenal mucosa (H & E x400) - suggestive of lymphoma.

Neuroendocrine tumours

These are a group of islet cell tumours accounting for 1-5% of all pancreatic neoplasms¹⁵ and show male preponderance typically occurring in the 5th decade. They usually present as solitary lesions and may be associated with genetic syndromes like Multiple endocrine neoplasia type 1 (MEN 1), Von Hippel-Lindau (VHL), Neurofibromatosis type 1 (NF1) and Tuberous Sclerosis (TS).

They are classified as functional and non-functional based on hormonal production. The functional tumours are diagnosed early because of systemic symptoms and are commonly less than 3 cm in size at presentation. These include insulinomas in whom hypoglycemia is invariably seen, gastrinomas causing multiple peptic ulcer, glucagonomas presenting with diabetes, anaemia, weight loss and rash, VIPomas with WDHA syndrome association and somatostatinomas presenting with diabetes, cholelithiasis and steatorrhea. Patients with non-functioning tumours usually present with symptoms of mass effect.¹⁵ These tumours are hyperenhancing with development of cystic and necrotic areas on progression and show no typical calcifications¹⁵ (Table 1). The most useful discriminator of malignant risk is tumour size with 90% of tumours under 20 mm being benign and 71% over 20 mm being malignant.¹⁵

Primary carcinoid tumour of the pancreas is extremely rare and can present early with symptoms like flushing, abdominal pain, diarrhoea and weight loss. On CT most of them are hypo or isodense (Figure 7A) enhancing in the arterial phase (Figure 7B). Rarely do they show enhancement in the portal venous phase. Larger tumours can show peritumoural lymphatic infiltration.¹⁶ Hypervascular hepatic metastases are common (Figure 7C).

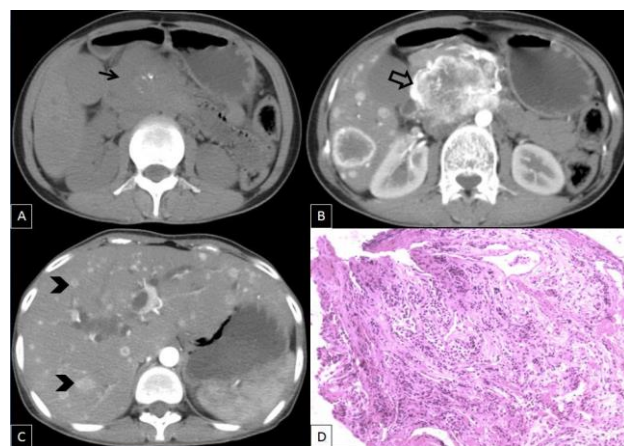


Figure 7: Axial unenhanced sections (A) show mass lesion with calcification in head and neck of pancreas (arrow). Axial sections in arterial phase (B) show hyperenhancement within the tumour (open arrow). Axial section in venous phase (C) shows multiple hypodense lesions in the liver and spleen (arrow head). Histopathological section (D) shows relatively monomorphic neuroendocrine cells. (H & E x40) - suggestive of carcinoid.

Management of pancreatic neoplasms

Surgery is the preferred therapeutic option for adenocarcinoma and islet cell tumours. Serous cystadenomas are usually benign tumors and rarely require surgical excision. The management of Intraductal Papillary Mucinous Neoplasm (IPMN) and Mucinous

Cystic Neoplasm (MCN) of the pancreas to treat conservatively or operate are guided by the Sendai criteria.¹⁸ Cyst size greater than 3 cm, main pancreatic duct diameter greater than 10 mm, symptomatic cyst, mural nodule, cyst fluid cytology suspicious or positive for malignancy are some of the criteria where surgery is advised. CT and MRI with added multiplanar reconstruction techniques provide roadmap for the surgeons. Pancreatic neoplasm are said to be unresectable on imaging when there is vessel involvement (celiac trunk and its branches, superior mesenteric vein, IVC, renal vein), adjacent organ involvement (Spleen, colon, small bowel, stomach, adrenal gland) and evident metastasis (Hepatic, peritoneal carcinomatosis, hematogenous distant spread). These imaging features have to be looked upon for better outcome in surgical management.¹⁷

CONCLUSION

Each pancreatic neoplasm has its own typical clinical presentation and CT characteristics though a small overlap may occur in some of them. A knowledge about them not only helps in diagnosis but also in the management regarding the tumour resectability.

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