Abdominal Imaging

Published online: 11 March 2011

Abdom Imaging (2012) 37:91–97
DOI: 10.1007/s00261-011-9720-2

Incidentally discovered solid pancreatic masses: imaging and clinical observations

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Abstract

Purpose: The purpose of this study was to review the CT findings and clinical outcome in patients with incidentally discovered solid pancreatic masses.
Materials and methods: Over an 8-year period, from 2001 to 2009, we identified 24 patients with solid pancreatic masses incidentally detected by CT. There were 13 females and 11 males, with a mean age of 67 years. We determined the indication for initial CT, analyzed the CT features, and ascertained the clinical follow-up in all the patients.
Results: All of the solid masses were malignant. There were 14 adenocarcinomas and 10 neuroendocrine tumors. The most common indications for the initial CT were surveillance of an extrapancreatic malignancy ($n = 10$) and evaluation for hematuria ($n = 6$). On the initial CT, 16 of the patients (67%) had a clearly visible pancreatic mass. In eight patients isoattenuating masses were identified, only recognized by subtle signs including unexplained dilatation of the pancreatic duct ($n = 5$) or minimal contour deformity or density of the pancreas ($n = 3$). The mean survival time for the patients with adenocarcinoma was 21.6 months, and 42 months for the patients with neuroendocrine tumors.
Conclusion: Although uncommon, incidentally discovered solid pancreatic masses are malignant neoplasms, either ductal adenocarcinomas or neuroendocrine tumors. Unlike incidentally discovered small cystic lesions, solid pancreatic lesions are often biologically aggressive.

Key words: Computed tomography—Pancreas—Solid masses—Adenocarcinoma—Neuroendocrine tumor

Numerous reports in the CT literature have noted the increasing detection of incidental pancreatic cysts of low malignant potential, likely the result of scanning with higher resolution in the multidetector CT era [1–4]. Incidentally discovered solid pancreatic lesions, however, have been the subject of few clinical or imaging investigations [5–10]. The purpose of our study was to analyze the CT features and clinical outcome in patients with incidentally discovered solid pancreatic lesions during an 8-year interval. The importance of recognizing subtle or indirect CT signs of an underlying pancreatic mass is highlighted.

Materials and methods

After obtaining institutional review board approval, we retrospectively reviewed all of our dedicated pancreatic protocol CT scans from July 1, 2001 to July 1, 2009 to identify patients who had been referred for assessment of solid pancreatic masses. There were 321 patients with solid pancreatic masses; 24 (7%) of these patients were identified incidentally as they had no clinical or laboratory findings suggestive of a pancreatic mass and were scanned initially for indications other than suspected pancreatic disease. All 24 patients were subsequently referred for a dedicated pancreatic protocol CT to accurately characterize a suspected pancreatic lesion based on their prior CT. These 24 patients are the focus of our study. There were 13 females and 11 males, with ages ranging from 46 to 86 years, with a mean of 67 years.

Twenty-two of the 24 patients had CT scans performed with intravenous contrast, and two had non-contrast scans only. There were multiple contrast injection protocols in this series, tailored to the clinically suspected abnormality, and the contrast injection rates varied from 2.5 to 5 mL/sec depending on the protocol. The volume of contrast injection ranged from 120 to 180 mL with concentrations ranging from iopamidol, Isovue 300 to iopamidol, Isovue 370 (Bracco Diagnostics, Princeton, NJ). The protocols included two patients with pulmonary embolus studies, two patients with CT angiography to evaluate the abdominal aorta, six

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patients with CT IVP or renal mass protocols for hematuria, and two patients with triphasic liver studies performed for HCC surveillance. The remaining ten patients had single-acquisition, portal-venous-phase imaging for extrapancreatic tumor surveillance. Similarly, the slice thickness of these studies varied from 1.5 to 5 mm. Scans were performed with single-row (8 patients), 4-row (12 patients), or 16-row (4 patients) multidetector CT (GE CTI, Hi Speed, Light Speed; General Electric Corp, Milwaukee, WI).

All ten patients with neuroendocrine tumors underwent surgical resection. Of the 14 patients with adenocarcinoma, 8 underwent surgical resection and 6 had endoscopic ($n = 5$) or percutaneous biopsy ($n = 1$) to confirm the diagnosis.

CT images were analyzed concurrently by two experienced abdominal radiologists (MG and RJ) who reached consensus about all of the findings. The presence of a solid pancreatic mass was confirmed, and the largest diameter of the mass was measured. In addition, images were analyzed for indirect signs of a pancreatic mass, including the presence of a dilated pancreatic duct (the interrupted pancreatic duct sign), dilated biliary duct, mass effect and/or pancreatic contour abnormality, subtle effacement of pancreatic fat by soft tissue, and atrophic distal pancreatic parenchyma.

Results

There were multiple clinical indications for the initial CT as outlined in Table 1. The two most common were routine surveillance of a known malignancy ($n = 10$) and hematuria ($n = 6$). The patients with malignancies undergoing surveillance included prostate cancer ($n = 2$); lung cancer ($n = 2$); hepatocellular carcinoma ($n = 2$); and one patient each with bladder, cervical, breast, and renal cell carcinoma. Within the tumor surveillance group, in retrospect, two of these ten patients had pancreatic abnormalities missed CT scans 6 and 8 months before the CT examination that suggested a pancreatic lesion. Both of these patients had subtle dilatation of the main pancreatic duct.

There were 14 patients with proven ductal adenocarcinoma of the pancreas and 10 with neuroendocrine tumors. All of the neuroendocrine tumors were felt to be non-functional on the basis of hormonal assays. The locations of the masses included twelve patients (50%) with lesions in the body of the pancreas, five patients (21%) with tumors in the uncinate process, five patients (21%) with lesions located in the tail of the pancreas, and only two patients (8%) with lesions in the head of the pancreas. A summary of the CT findings is included in Table 2.

Table 1. Indication for CT (24 patients)

Surveillance of known extrapancreatic malignancy	10 patients
Hematuria; r/o renal stones or masses	6 patients
Aortic aneurysm evaluation	2 patients
Suspected pulmonary embolus	2 patients
Ovarian cyst	2 patients
Sclerosing mesenteritis	1 patient
CT screening during physical examination	1 patient

Table 2. Summary of CT findings

Adenocarcinomas (14 patients)	
Hypodense mass	8 patients
Hyperdense mass	0 patients
Isodense mass	6 patients
Interrupted duct sign	5 patients
Distal pancreatic atrophy	1 patient
Fat effacement within mass	1 patient
Contour deformity	1 patient
Vascular encasement	7 patients
Hepatic metastases	1 patient
Neuroendocrine tumors (10 patients)	
Hypodense mass	1 patient
Hyperdense mass	7 patients
Isodense mass	2 patients
Interrupted duct sign	2 patients
Distal pancreatic atrophy	1 patient
Fat effacement within mass	0 patients
Contour deformity	1 patient
Vascular encasement	0 patients
Hepatic metastases	0 patients

Of the 14 patient with adenocarcinoma, eight had a hypodense mass and six had isodense masses. Of the ten patients with neuroendocrine tumors, seven had hyperdense masses, two had isodense masses, and one had a hypodense mass. Thus, overall 16 of the 24 patients had clearly identifiable pancreatic masses on the initial CT (Fig. 1). However, eight of the lesions were isoattenuating on the initial scan and were only evident on the basis of subtle or indirect signs, including a dilated distal main pancreatic duct greater than 3 mm (five patients), subtle contour deformity (two patients), or subtle attenuation difference with fat effacement within the mass (one patient) (Figs. 2, 3, 4, 5, 6, and 7)

Of the 14 adenocarcinomas, the size of the lesions in maximum diameter ranged from 1.8 to 5.2 cm, with a mean of 3.2 cm. Of the ten neuroendocrine tumors, the maximum diameter ranged from 1.3 to 5.2 cm, with a mean of 3.5 cm.

Of the 14 adenocarcinomas, six underwent surgery and eight were deemed unresectable at the time of presentation by virtue of CT evidence of locally advanced disease (seven patients) or liver metastases (one patient). Of the ten neuroendocrine tumors, all ten underwent pancreatic resection, and two patients had liver resection of metastases at the same time. Overall, 11 of the 24 patients had metastatic disease either evident on CT or detected at the time of surgery.

The survival for the 14 patients with proven adenocarcinoma ranged from 1 to 67 months, with a mean survival of 21.6 months; for the ten patients with neuroendocrine tumors, the survival ranged from 16 to

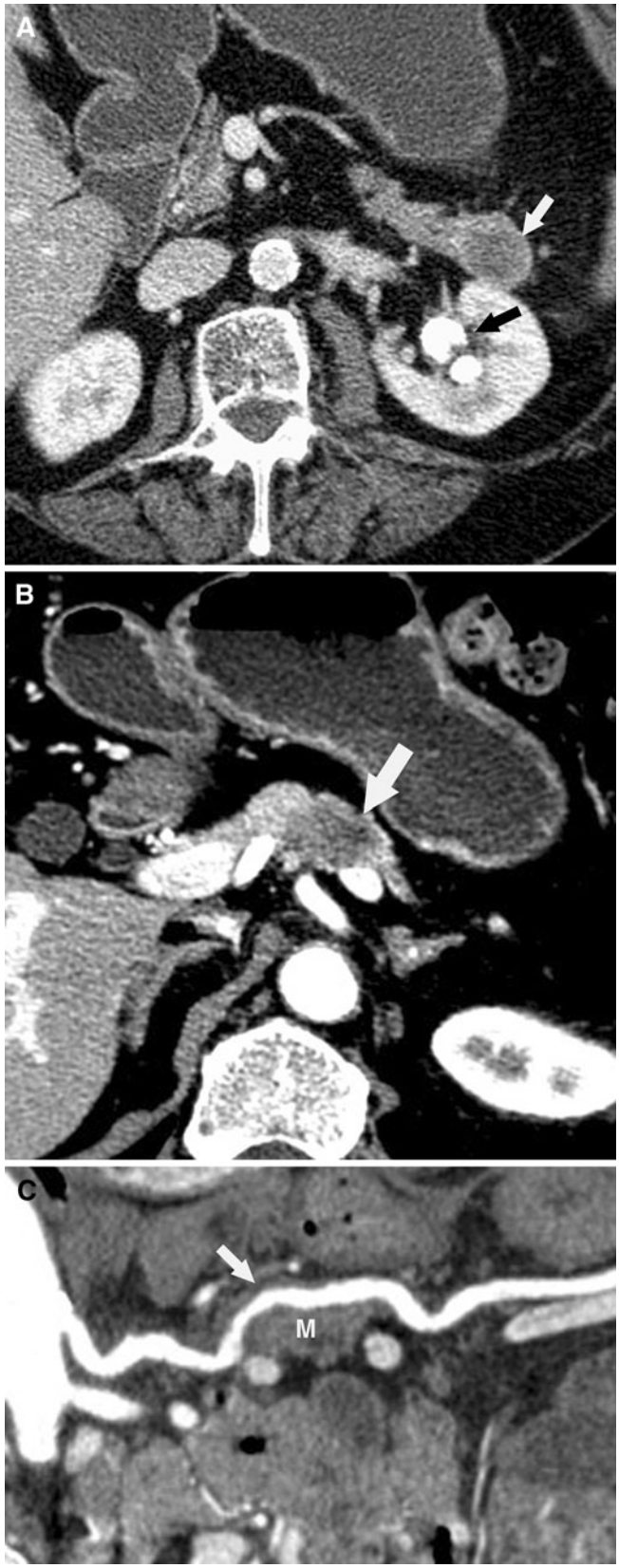

Fig. 1. **A**, **B**, and **C** Two patients with incidentally discovered adenocarciomas, readily visible on contrast CT. Figure **A** is an 86-year-old male evaluated for microscopic hematuria with CT urography. Note hypodense mass in tail of pancreas (*white arrow*) and renal calculi in renal pelvis of left kidney (*black arrow*). In **B**, contrast-enhanced CT performed in 56-year-old male undergoing HCC surveillance for hepatitis B, note hypodense adenocarcinoma in body of pancreas (*arrow*). **C** is curved-planar reformation from pancreatic protocol study in same patient as **B**, demonstrating splenic artery encasement (*arrow*) by pancreatic mass ("M"), rendering patient unresectable.

82 months, with a mean survival of 42 months. There were only four patients who survived 5 years or more: two patients with neuroendocrine tumors (74 and 82 months) and two patients with adenocarcinoma (60 and 67 months).

Discussion

Incidentally discovered solid pancreatic masses have been the subject of few reports in the imaging literature describing their imaging features and clinical outcome [5–9]. The clinical indications for the initial CT in our study were quite varied, including surveillance for extrapancreatic malignancy, pulmonary embolism studies, CT angiography studies, or evaluation for other abnormalities such as pelvic cysts. Because pancreatic disease was not suspected clinically, the scanning and contrast injection protocols were not optimized to visualize a pancreatic lesion and therefore, not surprisingly, a third of the patient in this series had very subtle or indirect signs of pancreatic malignancy. Many authorities feel that an optimal pancreatic CT involves a biphasic study with a rapid bolus injection performed during a late arterial-phase acquisition (25–40 s following injection) with a subsequent portal-venous-phase acquisition (60–70 s following injection) [11, 12]. In addition to the routine axial images, multiplanar imaging with detailed reformations often including curved-planar reformations, volume-rendered images, and minimum-intensity images have been shown to be quite valuable in assessing suspected pancreatic masses and their relationship to the pancreatic and common bile ducts as well as peripancreatic vessels [13].

The indirect signs of a pancreatic mass that were most valuable in this series included unexplained dilatation of a cut-off distal pancreatic duct (the "interrupted duct" sign) by an underlying isodense mass or subtle alteration in the pancreatic contour or attenuation. Prokesch et al. [14] noted that 11% of 53 pancreatic adenocarcinomas studied with a contrast-enhanced biphasic pancreatic protocol were isoattenuating to the normal pancreas. They emphasized the "interrupted duct sign" as an important indirect sign of an underlying pancreatic mass. The interrupted duct sign refers to dilatation of the upstream distal pancreatic duct by an isodense pancreatic mass. In our series, this finding was present in five

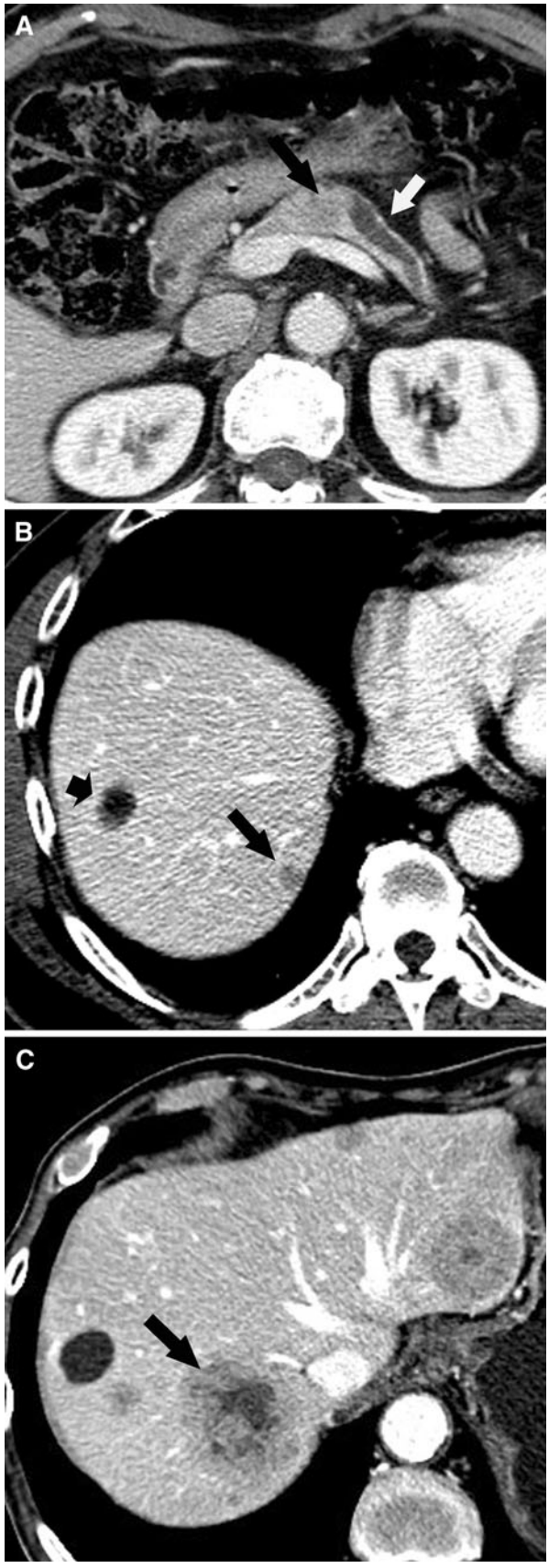

Fig. 2. **A**, **B**, and **C** Incidentally discovered pancreatic adenocarcinoma presenting with hepatic metastasis in a 70-year-old male undergoing surveillance for prostate cancer. In **A**, note slightly hypodense mass (*black arrow*) in body of pancreas obstructing pancreatic duct (*white arrow*). In **B**, note hypodense liver metastasis in dome of liver (*long black arrow*) and adjacent hepatic cyst (*short black arrow*). **C** is follow-up scan in same patient 6 months later, demonstrating marked interval enlargement of previously noted liver metastasis, with multiple new liver metastases (*black arrow*).

patients (four patients with adenocarcinoma and one with a neuroendocrine tumor).

Gangi et al. [5] retrospectively reviewed CT studies in 28 patients with pancreatic adenocarcinomas that had scans obtained months before the "diagnostic" CT scans obtained when they became symptomatic. They emphasized the importance of the interrupted duct sign that had been missed on the "pre-diagnostic" CT [5]. Their study only included adenocarcinomas and did not evaluate neuroendocrine tumors. In our study, we found that neuroendocrine tumors also may present similarly as isodense masses with an interrupted duct sign (Fig. 7), and rarely may even present as hypodense mass. The importance of diagnosing neuroendocrine tumors is underscored by the fact that the mean survival in our series was twice that of patients with adenocarcinomas (42 vs. 21.6 months).

In addition to the interrupted duct sign that has been stressed by several other authors [5, 14, 15], we wish to emphasize that subtle increased density within the pancreas that effaces the normal interdigitating pancreatic fat is a sign to look for as well (Fig. 5). Subtle contour abnormalities such as rounding of the uncinate process should raise suspicion for a pancreatic mass (Fig. 4).

Unexplained dilatation of a portion of the main pancreatic duct >3 mm should always raise suspicion for an underlying pancreatic mass and thus should prompt an endoscopic ultrasound examination or a dedicated pancreatic protocol CT or MR. While in some patients there may be evidence of distal parenchymal atrophy, this is not always the case; in the majority of our cases the duct was simply dilated without an obvious explanation. In two patients the contour abnormality was largely reflected by effacement of the underlying pancreatic fat (Fig. 5). As part of the normal aging process, it is not uncommon to see areas of fat interdigitating with pancreatic parenchyma. However, focal obliteration or effacement of the fat should similarly raise suspicion for an underlying parenchymal mass. Despite the fact that there were few early phase arterial acquisitions, many of the neuroendocrine tumors in this series were clearly evident as a hypervascular mass (Fig. 6). None of these were functional neuroendocrine tumors, but histologically all were felt to be malignant at

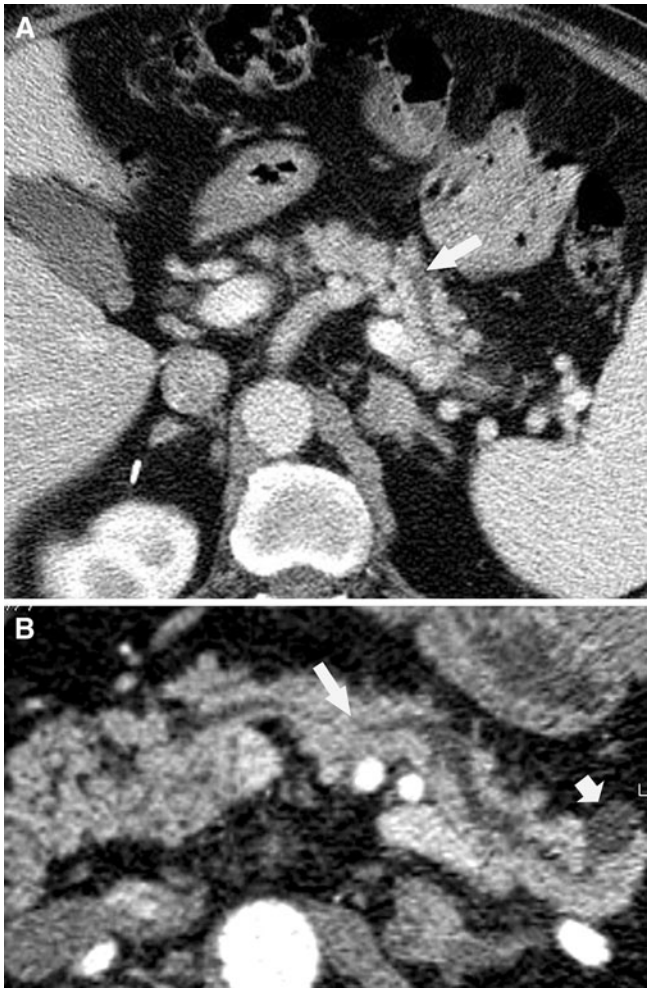

Fig. 3. **A** and **B** Incidental pancreatic adenocarcinoma identified by interrupted duct sign. Patient is 74-year-old male undergoing surveillance for partial nephrectomy for renal cell carcinoma of right kidney 2 years previously. In **A**, note focal dilatation of the pancreatic duct in body and tail of pancreas without evidence of underlying mass. Figure **B**, dedicated pancreatic protocol CT 1 week later demonstrates focal narrowing of main pancreatic duct on curved-planar reformation through main pancreatic duct (*long white arrow*) caused by probable underlying isoattenuating small mass. Incidentally noted is side-branch IPMN in tail of pancreas (*short white arrow*). At endoscopic ultrasound, ductal adenocarcinoma was diagnosed on FNA biopsy and confirmed surgically at distal pancreatectomy.

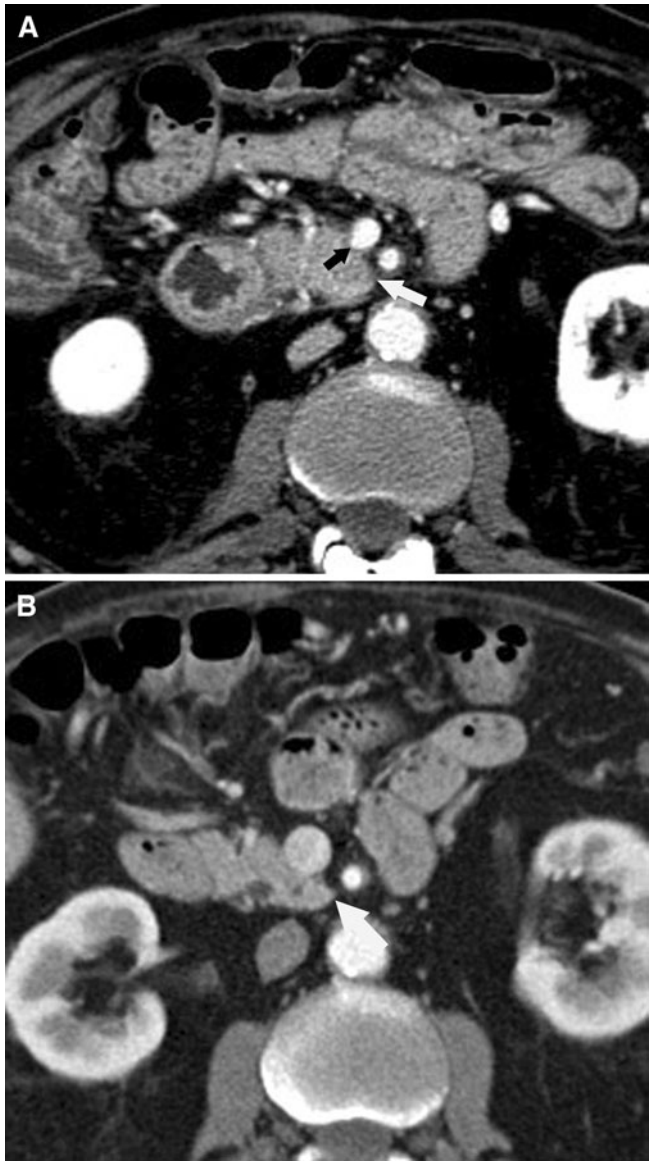

Fig. 4. **A** and **B** Incidental adenocarcinoma of uncinate process detected on surveillance study for follow-up of sclerosing mesenteritis in 62-year-old male. In **A**, note subtle rounded appearance of uncinate process (*long arrow*) and teardrop configuration of superior mesenteric vein (*short arrow*) consistent with adventitial invasion. Figure **B**, prior scan obtained 4 years previously for same indication demonstrates normal sharp, V-shaped appearance of uncinate process (*arrow*). Patient had adenocarcinoma confirmed by FNA biopsy during endoscopic sonography and was deemed unresectable due to superior mesenteric invasion.

pathology. Therefore, even with portal-venous-phase acquisitions, although not optimally timed for the arterial phase, hypervascularity within a mass can be appreciated and should suggest the presence of a neuroendocrine tumor.

Unlike the benign nature of the majority of incidentally discovered pancreatic cysts, all of the solid masses detected in our series were malignant adenocarcinomas or neuroendocrine tumors [1–3]. Of note is the fact that of the 14 adenocarcinomas in our series, only 6 underwent surgery and the other 8 were deemed unresectable at the time of presentation by virtue of CT evidence of locally advanced disease (7 patients) or liver metastases (1 patient). The poor clinical outcome in our patients with adenocarcinoma was similar to other published series examining incidental pancreatic adenocarcinomas in the surgical literature. Winter et al. [9] at a large

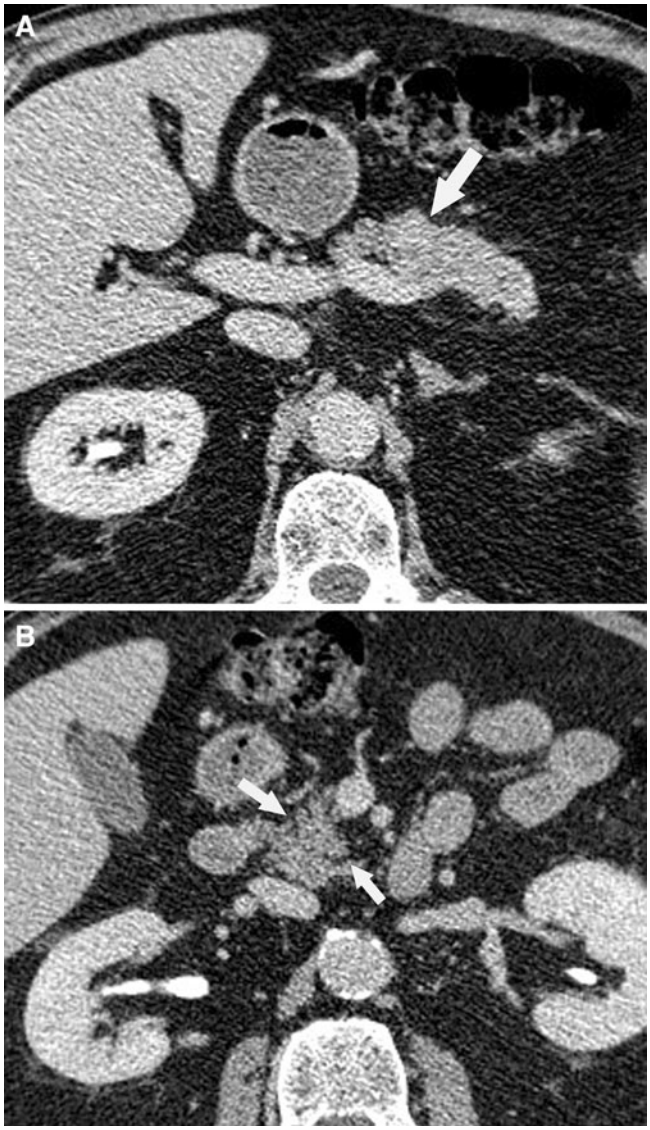

Fig. 5. **A** and **B** Incidentally discovered adenocarcinoma in 80-year-old male undergoing surveillance for prostate cancer. In **A**, note subtle increased attenuation within body of pancreas (*arrow*) with effacement of normal intrapancreatic fat. In **B**, note normal interdigitating fat (*arrows*) within head and uncinate of pancreas that is absent in area of mass in tail of pancreas.

pancreatic surgery center, reviewed their 8-year experience with incidental periampullary and pancreatic lesions, and detected ten pancreatic ductal adenocarcinomas. The median survival for their ductal adenocarcinoma group was 28 months vs. our mean survival of 21.6 months [9]. Thus, it is likely that incidentally discovered ductal adenocarcinomas are already biologically aggressive lesions, associated with a poor prognosis at the time of diagnosis. The overall survival for the neuroendocrine tumors, however, was substantially better than the ductal adenocarcinomas, with a mean survival of 42 months.

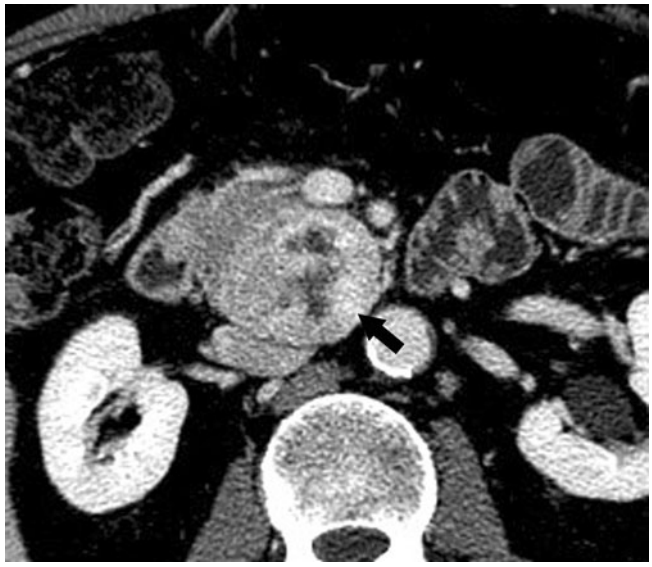

Fig. 6. 66-year-old male undergoing surveillance for bladder cancer. Note neuroendocrine tumor evident as hypervascular mass (*arrow*) even on portal-venous-phase acquisition with central necrosis in uncinate process.

One factor that may have contributed to the poor outcome in our patients was the location of the masses within the pancreas. Only two of our twenty-four patients (8%) had tumors located in the head of the pancreas. Unlike tumors in the head of the pancreas, lesions within the uncinate process, body or tail of the pancreas will not result in early obstruction of the common bile duct and the clinical sign of painless jaundice. Therefore, early diagnosis of malignancy when the mass is small is often not possible for lesions in these anatomic locations. It should be noted, however, that four patients (two with adenocarcinoma and two with neuroendocrine tumors) survived for 5 years or more. Therefore, in a small number of patients, detection at a relatively early stage by serendipity may aid in prolonging survival.

There are several limitations to the retrospective nature of our study. It is possible that we have underestimated the number of incidental solid pancreatic masses by virtue of the fact that we only evaluated patients subsequently referred for a dedicated pancreatic protocol CT. Patients may have gone to another institution for further evaluation after the pancreatic mass was discovered, or been referred directly to endoscopic ultrasound.

In summary, although uncommon, incidentally discovered solid pancreatic masses detected during CT performed for indications other than pancreatic disease have far different clinical implications when compared to incidentally discover small cystic lesions. Unlike small cystic lesions which are almost always benign, all of the solid lesions in our series were either malignant, ductal adenocarcinomas, or malignant neuroendocrine tumors.

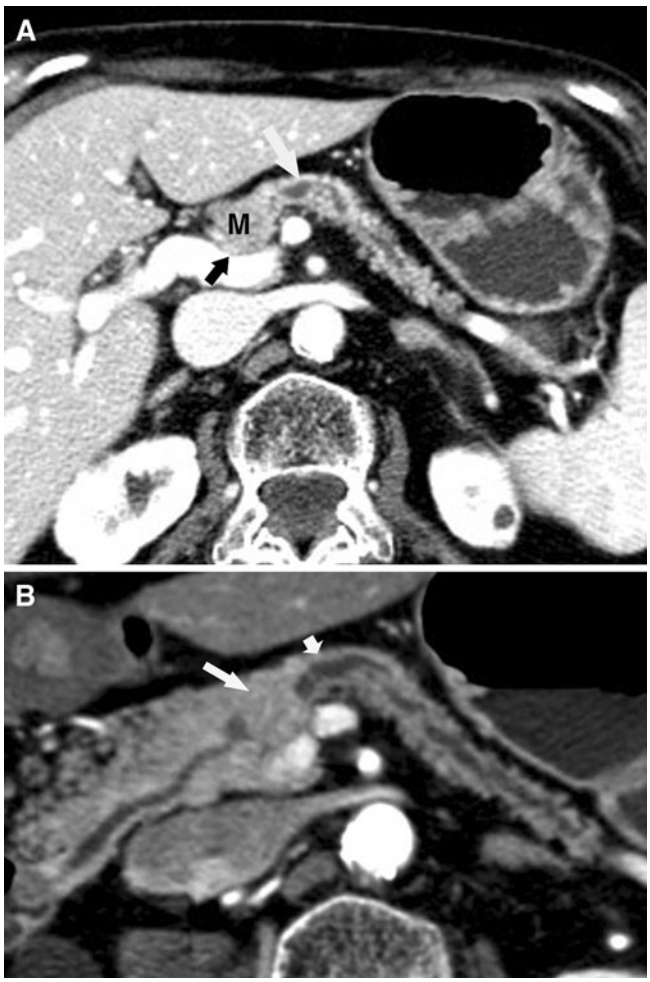

Fig. 7. **A** and **B**. Small neuroendocrine tumor in neck of pancreas, evident primarily through interrupted duct sign, in 72-year-old female patient undergoing CT evaluation of microscopic hematuria. In **A**, note dilatation of main pancreatic duct (*white arrow*) and subtle isodense mass ("M") causing slight mass effect on portal vein (*black arrow*). Figure **B**, dedicated curved-planar reconstruction in same patient obtained from subsequent pancreatic protocol CT imaging performed 11 days later confirmed distal upstream obstruction of main pancreatic duct (*short white arrow*) by isoattenuating mass in neck of pancreas (*long white arrow*).

Most were identified in elderly patients undergoing routine surveillance for known extrapancreatic malignancies or renal indications such as hematuria. One-third of the patients in this series had subtle isodense masses evident only by indirect signs such as the unexplained dilatation of the pancreatic duct or subtle density or contour changes to the pancreas. A very high percentage (92%) of these lesions was not located in the head of the pancreas, and thus none of the patients had signs of jaundice. Although often biologically aggressive lesions, there were a number of individuals with prolonged survival in our series, especially among patients with neuroendocrine tumors. Thus, detection of these incidental tumors lesions may be an important contribution to their clinical outcome.

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