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Pancreatic metastases: CT and MRI findings

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PURPOSE
The pancreas is an unusual but occasionally favored site for metastases in patients with advanced malignancy. The pivotal role of computed tomography (CT) and magnetic resonance imaging (MRI) examination in detecting the pancreatic mass and providing guidance to obtain a definitive tissue diagnosis is emphasized in this study.

MATERIALS AND METHODS
Eleven patients with pancreatic metastases, 4 women and 7 men with a mean age of 62.45 years, were examined in a period of 5 years. All patients underwent CT examination and 3 patients were further evaluated by MRI.

RESULTS
The primary malignancy was lung carcinoma in 7 patients, breast carcinoma in 3 patients and renal cell carcinoma in 1 patient. The pancreatic metastases were detected during initial staging in 4 cases and during follow-up in 7 cases. The type of metastases was solitary in 7 patients, multiple in 3 patients and diffuse in 1 patient, with rim or homogeneous enhancement. Seven patients had metastases to other organs. CT-guided biopsy was performed in 5 patients.

CONCLUSION
Disparity in prognosis and management of patients with secondary pancreatic tumors makes detection and characterization of metastases to the pancreas an important goal of CT and MRI evaluation.

Key words: • *neoplasm metastasis* • *pancreatic neoplasms* • *computed tomography* • *magnetic resonance imaging*

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Pancreatic metastases are rare, with a reported incidence varying from 1.6% to 11% in autopsy studies of patients with advanced malignancy. In clinical series, the frequency of pancreatic metastases ranged from 2% to 5% of all pancreatic malignant tumors (1–5). The most common primary tumors to give rise to pancreatic metastases are renal cell carcinoma, lung cancer, breast cancer and colorectal carcinoma followed by malignant melanoma and leiomyosarcoma (1, 6). The disparity in prognosis and management of patients with primary and secondary pancreatic tumors, as well as the fact that in very selected cases a radical surgical resection can be considered as treatment of pancreatic metastases and achieve prolonged survival, underlines the importance of detection and characterization of these lesions on computed tomography (CT) and magnetic resonance imaging (MRI) (1, 6, 7). CT can also be considered as an important tool in providing guidance in order to obtain a definitive tissue diagnosis in controversial cases (1, 2, 7).

Material and methods

In a period of 5 years, between January 2002 and January 2007, 11 patients with pancreatic metastases, 4 women and 7 men, were examined. Patients' ages ranged from 27 to 78 years with a mean age of 62.45 years. All patients underwent CT examination and 3 patients were further evaluated by MRI. CT-guided biopsy was performed in 5 cases. Patients with neoplastic involvement of the pancreas by direct extension from adjacent viscera, as well as patients with metastatic involvement of peripancreatic lymph nodes but not of the pancreas itself, were excluded from the study.

CT scans were obtained with a Picker PQ 5000 CT scanner device with slice thickness, 5 mm; pitch, 2; reconstruction interval, 5 mm; FOV, ranging from 320–400 mm depending on the patient's size. Images were obtained after contrast agent administration during portal phase (60–70 s after injection). A bolus injection of 120–150 mL (3–4 mL/s) of non-ionic contrast medium was given.

MRI scans were obtained with a Siemens 1 T scanner (Siemens Expert Plus, Erlangen, Germany). Before contrast administration, axial and coronal HASTE T2-weighted images (TR, 6 ms; TE, 60 ms) were obtained with a slice thickness of 8 mm; FOV, 340–400 mm depending on patient's size; and matrix, 256 x 192. After administration of 10 mL of contrast agent axial FLASH T1-weighted images (TR, 11 ms; TE, 4.2 ms) were obtained with a slice thickness of 8 mm; FOV, 340–400 mm, matrix, 256 x 192.

CT guided pancreatic biopsies were performed using 18 G cutting needles with the coaxial technique (Temno Evolution, Cardinal Health, Orlando, Florida, USA). All patients were informed and gave their written consent before biopsy.

Results

The primary malignancy was lung carcinoma in 7 patients, breast carcinoma in 3 patients, and renal cell carcinoma in 1 patient. Of the 7 patients with lung carcinoma, 2 patients had small cell carcinoma and 5 patients non-small cell carcinoma; 3 patients had adenocarcinoma and 2 patients squamous cell carcinoma (Figs. 1 and 2). All 3 patients with breast cancer had infiltrative lobular carcinoma. Pancreatic metastases were detected during initial staging (within 2 weeks from diagnosis of primary carcinoma) in 4 patients and during follow-up in 7 patients. In the latter case, the time interval between diagnosis of the primary tumor and detection of pancreatic metastases ranged from 13 to 50 months (mean, 29.4 months).

At the time of detection of pancreatic metastasis 6 patients were asymptomatic and in 2 of these patients the diagnosis was set during the initial staging of the primary tumor. Clinical symptoms in the 5 symptomatic patients included abdominal pain in 3 patients, vomiting in 2 patients and jaundice in 3 patients (Table).

Pancreatic metastases were solitary in 7 patients (63.6%), multiple in 3 patients (27.3%) and diffuse in 1 patient (9%) causing generalized enlargement of the organ (Fig. 3). In 10 patients with solitary and multiple metastases 18 tumors were detected; 5 tumors were located in the head of the pancreas (27.8%), 2 in the neck (11.1%), 6 in the body (33.3%) and 5 in the tail (27.8%). Tumors showed no predilection for a particular part of the organ with the neck being less commonly involved.

Size of the tumors ranged from 1.2 cm to 5.2 cm (mean, 2.75 cm). Lesions were solid in 10 patients and cystic with multifocal distribution in 1 patient with small cell lung carcinoma (Fig. 4). Margins of the tumors were well-defined in 9 patients; smooth in 6 patients and lobulated in 3 patients. In 2 cases the margins of the lesions were ill-defined; 1 with multiple and 1 with diffuse distribution (Table).

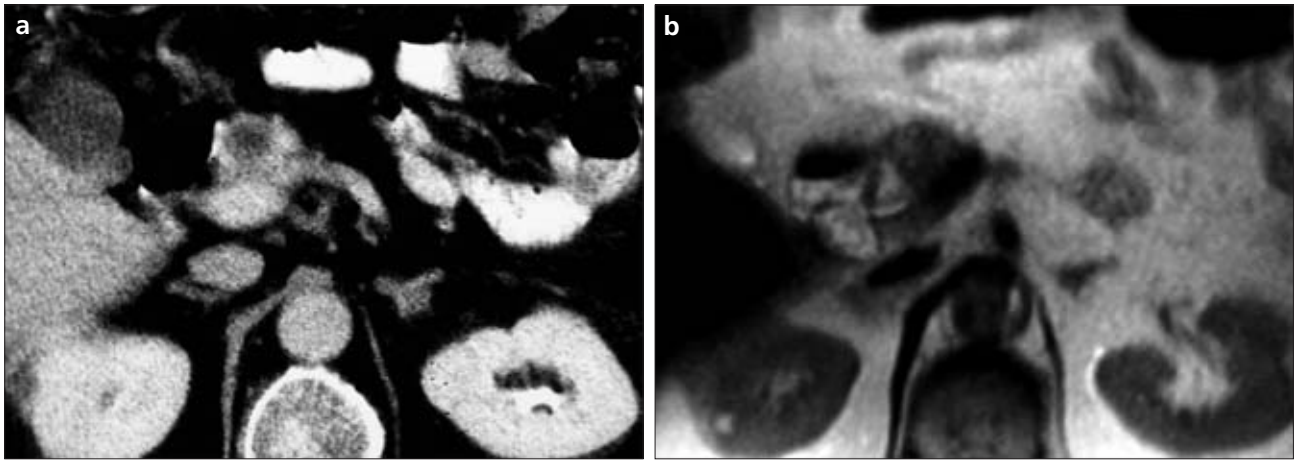
Enhancement pattern of pancreatic metastases on CT and MRI was homogeneous in 3 patients; 2 with solitary metastases from lung adenocarcinoma and squamous cell carcinoma and 1 with multiple metastases from renal cell carcinoma (Fig. 5). In the remaining 8 patients, pancreatic metastases demonstrated rim enhancement pattern. Of the 3 patients who underwent further MRI evaluation, pancreatic metastases had intermediate signal intensity on T2-weighted images in all cases.

At the time of detection of the pancreatic metastases, 7 patients had metastases to other organs; 3 patients had adrenal metastases, 2 patients metastases to the pararenal space, 2 patients metastases to the lumbar spine, 2 patients metastases to mediastinal lymph nodes, 1 patient had brain metastases and metastases to pancreaticoduode-

Table. Clinical data and imaging findings in 11 patients with pancreatic metastases

Primary tumor	Gender	Age	CT-MRI	Diagnosis	Symptoms	Types of metastases	Location of pancreatic metastases	Size (cm)	Solid/cystic	Margins	Pattern of enhancement	Extrapancreatic metastases	CT guided biopsy
Breast	F	51	CT	Follow-up (38 months)	Asymptomatic	Solitary	Body	2.9	Solid	Smooth	Rim	Liver, R kidney, R adrenal LN (retroperitoneal-L gastric artery)	-
Lung (AdCa)	M	72	CT MRI	Initial diagnosis	Asymptomatic	Solitary	Neck	2	Solid	Smooth	Rim	-	+
Lung (AdCa)	M	78	CT	Initial diagnosis	Pain Vomiting	Solitary	Head	2.4	Solid	Smooth	Rim	-	+
Lung (AdCa)	M	68	CT MRI	Initial diagnosis	Pain Jaundice	Solitary	Head	4	Solid	Smooth	Homogeneous	-	+
Kidney	F	77	CT MRI	Follow-up (50 months)	Asymptomatic	Multiple (4)	Body (3) Tail (1)	1.2 - 2.8	Solid	Smooth	Homogeneous	Mediastinal LN, local recurrence	-
Lung (SqCC)	M	52	CT	Follow-up (35 months)	Asymptomatic	Solitary	Head	3.5	Solid	Lobulated	Homogeneous	Adrenals	-
Lung (SmCC)	M	69	CT	Follow-up (20 months)	Pain Vomiting	Multiple (5)	Head (1) Body (2) Tail (2)	1.5 - 5.2	Cystic	Smooth	Rim	Mediastinal LN, lumbar spine, bilateral pararenal space	-
Breast	F	27	CT	Initial diagnosis	Asymptomatic	Diffuse	-	-	Solid	Ill-defined	Rim	-	+
Lung (SqCC)	M	57	CT	Follow-up (26 months)	Asymptomatic	Solitary	Tail	3	Solid	Lobulated	Rim	L adrenal, L pararenal space	-
Breast	F	77	CT	Follow-up (24 months)	Jaundice	Solitary	Head	3.5	Solid	Lobulated	Rim	Lumbar spine	+
Lung (SmCC)	M	59	CT	Follow-up (13 months)	Jaundice	Multiple (2)	Head (1) Tail (1)	1.2 - 2.5	Solid	Ill-defined	Rim	Brain, pancreatoduodenal LN	-

AdCa, adenocarcinoma; SmCC, small cell carcinoma; SqCC, squamous cell carcinoma; M, male; F, female; R, right; L, left; LN, lymph nodes.



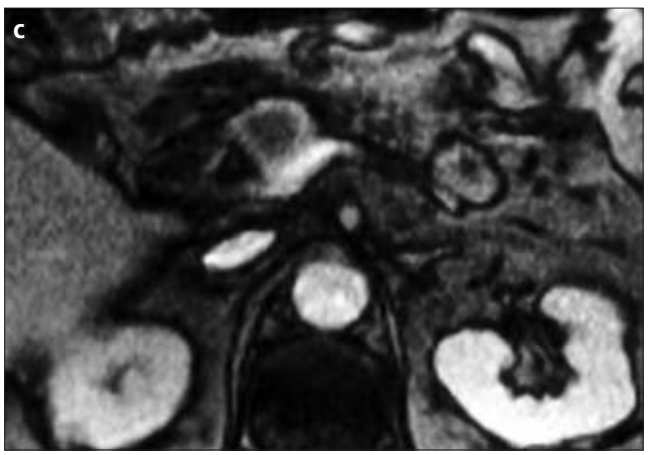


Figure 1. a–c. Contrast enhanced CT **(a)**, HASTE T2-weighted MR **(b)**, and contrast enhanced FLASH T1-weighted MR **(c)** images of a solitary metastasis in the neck of the pancreas, with rim enhancement and intermediate signal intensity on the HASTE T2-weighted MR image **(b)**, in a 72-year-old patient with lung adenocancinoma.

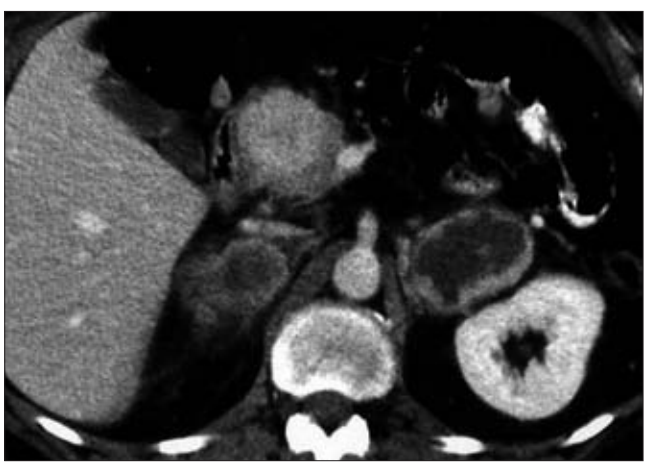


Figure 2. A homogeneously enhancing solitary metastasis in the head of the pancreas is visible on CT of a 52-year-old patient with squamous cell lung carcinoma and bilateral adrenal metastases.

nal lymph nodes, and 1 patient had concurrent adrenal, renal, hepatic metastases and metastases to retroperitoneal lymph nodes and lymph nodes of the left gastric artery.

None of the patients had demonstrable involvement of extrapancreatic arteries and veins. Calcification was not present in the pancreatic tumors. Moderate dilatation of the main pancreatic duct upstream from the lesion was apparent in 1 patient with lung adenocarcinoma and solitary metastases in the head of the pancreas.

CT-guided biopsy was performed in 5 patients. Out of these 5 patients, 3 had lung adenocarcinoma with solitary pancreatic metastases detected during initial staging. In these cases, the biopsy was performed in order to exclude a synchronous primary pancreatic tumor. The primary malignancy of the remaining 2 patients was lobular breast carcinoma. In 1 patient with diffuse pancreatic metastases and generalized enlargement of the gland, biopsy was performed in order to obtain a definitive tissue diagnosis and evaluate the possibility and type of chemotherapy. CT-guided biopsy was also performed in 1 patient with breast cancer and metastases to the lumbar spine. In this case, the pancreatic lesion was solitary and it was detected 24 months after initial staging. Biopsy was performed to exclude a synchronous primary pancreatic tumor and evaluate the possibility and type of chemotherapy. In this case, we had a small peripancreatic hematoma as a complication. A histological diagnosis was obtained in all cases. None of the remaining 6 patients underwent surgical treatment. As a result histological confirmation was not obtained in these cases and the diagnosis was based on patients' history, follow-up and radiological findings.

Discussion

Pancreatic metastatic lesions are uncommon and account for 2–5% of pancreatic malignancies (2, 3, 5). On the basis of studies involving large numbers of autopsies performed in patients with malignant neoplasms, the prevalence of pancreatic metastases has been reported to range from 1.6%

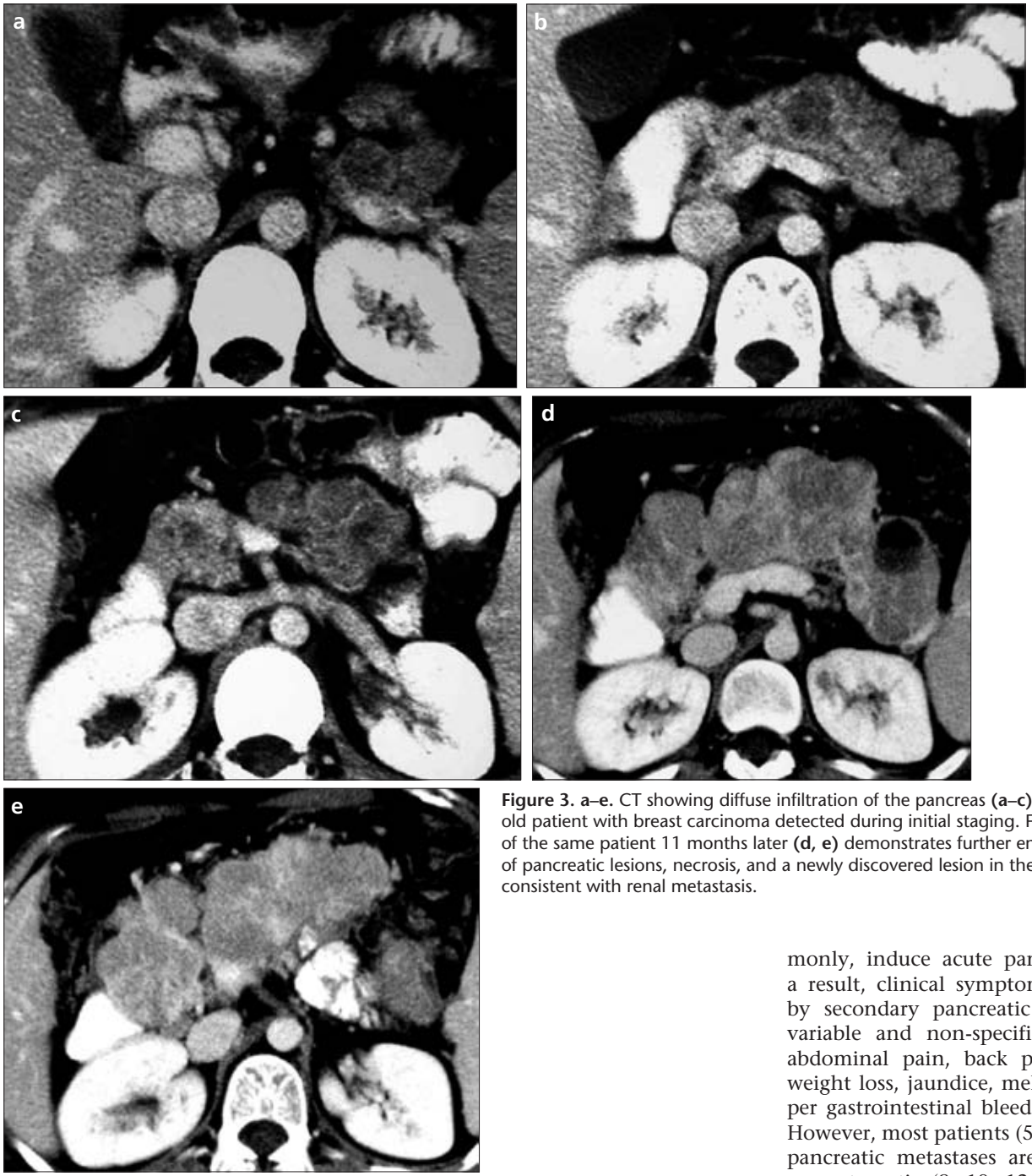


Figure 3. a–e. CT showing diffuse infiltration of the pancreas **(a–c)** in a 27-year-old patient with breast carcinoma detected during initial staging. Follow-up CT of the same patient 11 months later **(d, e)** demonstrates further enlargement of pancreatic lesions, necrosis, and a newly discovered lesion in the left kidney consistent with renal metastasis.

to 11% (1, 4). The tumors that metastasize most commonly to the pancreas are renal cell carcinoma, lung cancer, breast cancer and colorectal carcinoma followed by malignant melanoma and leiomyosarcoma (1, 6). In most studies lung carcinomas or renal cell carcinomas are reported to be the most common (4, 8–10), although one study from Japan indicated stomach cancer as the main source suggesting population based differences (11). In our study, the most common primary malignancy was lung carcinoma (63.6%) followed by breast carcinoma (27.3%), but renal cell carcinoma did not comprise a significant percentage (9%). Other primary malignancies that have been reported to give rise to pancreatic metastases are thyroid, prostate, ovarian, hepatocellular carcinomas and various types of sarcomas (4, 12, 13).

Pancreatic metastases may directly invade pancreatic ductal epithelium and thus clinically mimic primary pancreatic adenocarcinoma, or less commonly, induce acute pancreatitis. As a result, clinical symptoms produced by secondary pancreatic tumors are variable and non-specific, including abdominal pain, back pain, nausea, weight loss, jaundice, melena and upper gastrointestinal bleeding (12, 13). However, most patients (50–83%) with pancreatic metastases are completely asymptomatic (8, 10, 12, 13). In our study, 54.5% of patients were asymptomatic, 27.3% reported abdominal pain, 18.2% vomiting and 27.3% had jaundice. Out of the 3 patients with jaundice, 2 patients had a solitary metastasis in the head of the pancreas (3.5 cm and 4 cm in diameter, respectively) and 1 patient had metastases to pancreaticoduodenal lymph nodes. A moderate dilatation of the main pancreatic duct on CT, upstream from the solitary metastasis in the head of the pancreas, was present in 1 patient with abdominal pain and vomiting.

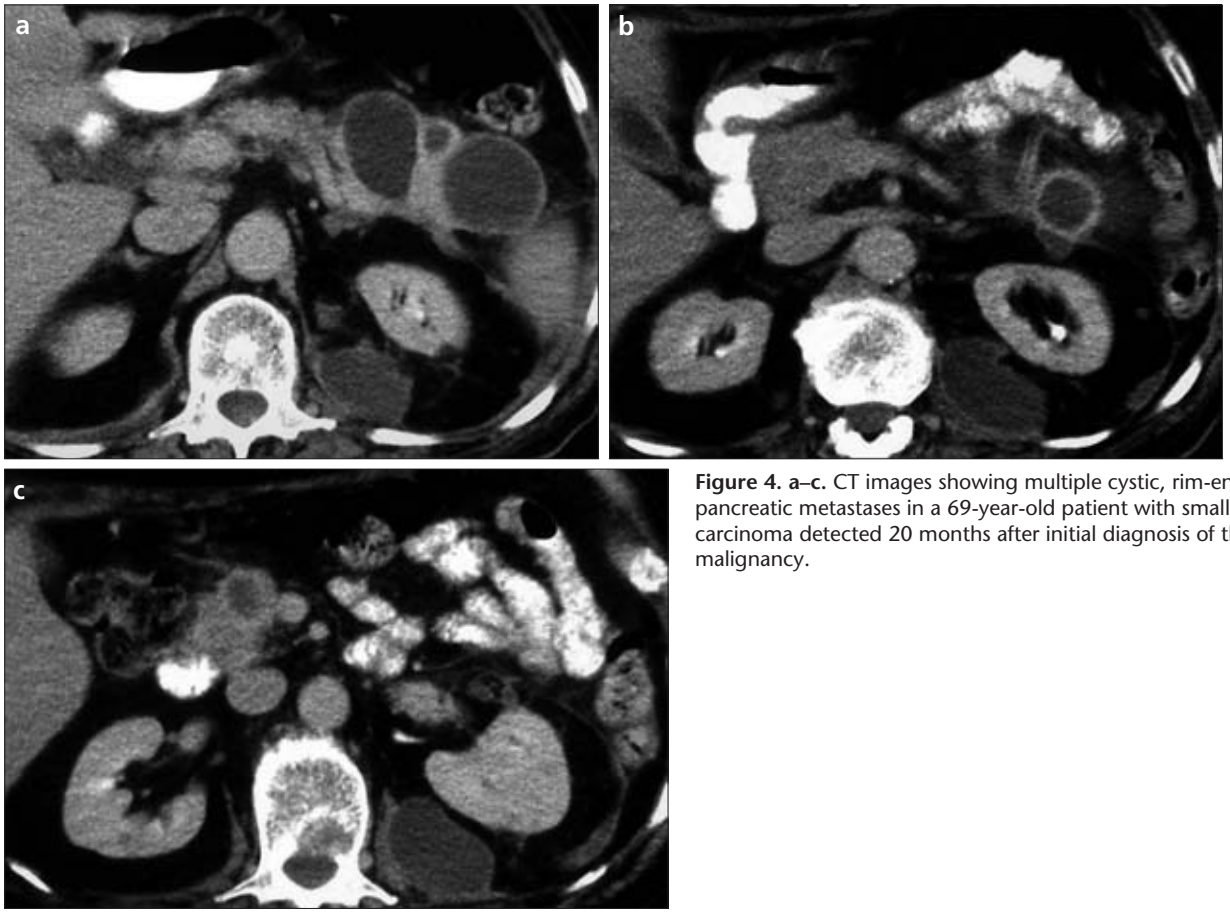


Figure 4. a–c. CT images showing multiple cystic, rim-enhancing pancreatic metastases in a 69-year-old patient with small cell lung carcinoma detected 20 months after initial diagnosis of the primary malignancy.

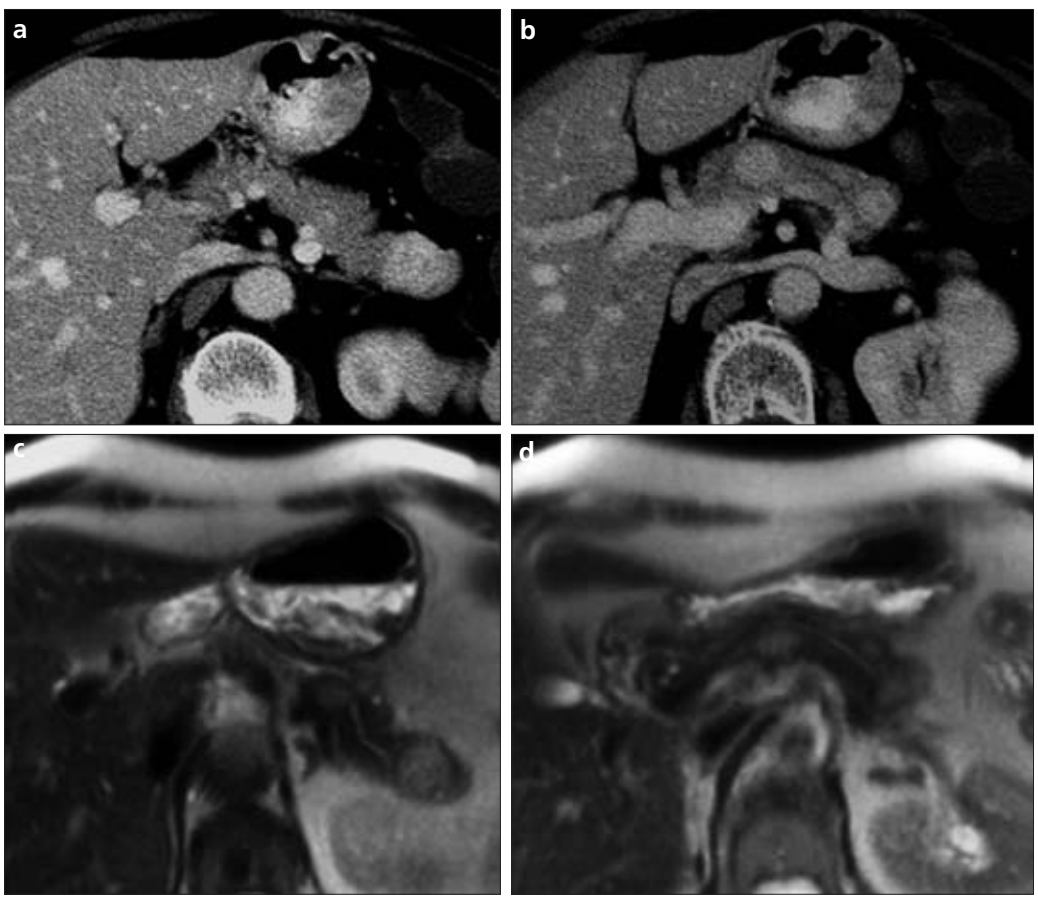


Figure 5. a–d. Multiple homogeneously enhancing metastases in the body and tail of the pancreas **(**CT images, **a, b)** with intermediate signal intensity on HASTE T2-weighted MR images **(c, d)** in a 77-year-old patient with right-sided renal cell carcinoma. Pancreatic metastases were detected 50 months after nephrectomy.

Pancreatic metastases do not appear to show a predilection for a particular part of the organ (9, 14). Three types of metastatic involvement of the pancreas have been described. The most common, reported in 50–73% of cases, is that of a solitary, localized, well-marginated mass. A second pattern of multiple pancreatic lesions has been reported in 5–10% of cases, and a third pattern of diffuse metastatic infiltration causing generalized enlargement of the organ in 15–44% of cases (2, 12, 15–17). In this study, the most common type was that of the solitary metastasis, present in 63.6% of patients, followed by the multiple metastases type in 27.3% of patients and the diffuse type in 9% of cases. Our results were more in accordance with those reported by Klein et al. (9) with the diffuse pattern being the most infrequent (4.5% of cases), the solitary type representing 78.8%, and the multifocal type 16.7% of cases.

Metastatic pancreatic tumors may also have certain features on contrast-enhanced CT and MRI that are more characteristic of their extrapancreatic source than of primary pancreatic carcinoma. Whereas ductal adenocarcinoma of the pancreas typically appears as a non- or poorly-enhancing mass, pancreatic metastases detected in our study showed peripheral (72.7%) or less commonly homogeneous (27.3%) enhancement. Therefore, the enhancement pattern of tumor tissue observed in all of our cases reflects a degree of vascular perfusion that is not typical of primary pancreatic adenocarcinoma. Several authors have also reported that rim enhancement is especially common in metastatic lesions larger than 1.5 cm in size, whereas smaller lesions tend to demonstrate homogeneous enhancement (9, 12, 13). In our study we did not observe a correlation between tumor size and pattern of enhancement.

When hypervascular pancreatic lesions are depicted on contrast-enhanced CT and MRI, differential diagnosis includes primary neuroendocrine tumors, metastases, intrapancreatic accessory spleen and vascular lesions such as arteriovenous fistulas or aneurysms of the splenic artery (1, 18–20, 21). In most cases the oncologic background and existence of previous follow-up of the neoplastic disease allows a correct diagnosis, and in controversial cases a CT-guided biopsy can be performed.

As far as the origin of pancreatic metastases is concerned, metastases from renal cell carcinomas are often described as hyperattenuating masses, a pattern that reflects hypervascularity of viable tumor tissue, typical of the primary malignancy (9, 12, 13). Although the solitary type is the most common in pancreatic metastases from renal cell carcinoma, multifocality of the lesions is not unusual, ranging from 20% to 45% in different reports (6, 20–24). Another specific characteristic of metastatic renal cell carcinoma is that pancreatic localization typically occurs a long period after initial nephrectomy, with a median interval ranging from 6.5 to 12 years, with the longest interval reported being 32.7 years (5, 6, 19–21, 23, 25, 26). In our case, multiple homogeneously enhancing pancreatic metastases were detected in a patient with renal cell carcinoma 50 months after initial diagnosis and nephrectomy, and a local recurrence of the primary tumor was detected at the same time.

The most common primary malignancy in this study was lung cancer with non-small cell carcinoma outnumbering small cell carcinoma. All patients with adenocarcinoma had a solitary solid pancreatic metastasis with smooth margins detected during initial diagnosis and no extrapancreatic metastases. In all cases of small and squamous cell carcinomas extrapancreatic metastases were present. Both patients with small cell carcinomas presented multiple pancreatic metastases with rim enhancement whereas in all other cases of lung carcinomas pancreatic metastases were solitary. Nevertheless, there is not sufficient data from the literature indicating a correlation between specific histological types of lung carcinoma and radiological findings, with the exception of reports stating that pancreatic metastases are more commonly encountered in patients with small cell carcinoma and that the solitary type is the most usual pattern (9, 16).

The importance of detection and characterization of pancreatic metastases on CT and MRI is underlined by the disparity in prognosis and management of patients with primary and secondary pancreatic tumors. In selected patients with pancreatic metastases, surgical resection can be considered as treatment and prolong survival. Data from the literature indicate that an improved survival can be achieved in patients with renal, breast, and colonic carcinomas and sarcomas as primary malignancy, while patients with melanoma and lung cancer are related with a poor outcome and should be treated non-operatively (5, 8, 19, 27, 28). Even in patients not amenable to surgery, a definitive tissue diagnosis can be helpful in evaluating the possibility and type of chemotherapy. In these cases and in controversial diagnostic cases, CT can be considered as an important tool in providing guidance in order to obtain a definitive tissue diagnosis (1, 2, 7, 9).

The limitation of this study is the fact that a histological diagnosis was not obtained in patients who did not undergo CT-guided biopsy because none of these patients had surgical treatment. In these cases diagnosis was based on patients' history, follow-up and radiological findings. Another limitation is the fact that during abdominal CT examination, arterial phase is not routinely included in our protocol for staging and follow-up of oncology patients. Therefore, hypervascular pancreatic metastases might have been underestimated, although according to Mecho et al. (21), all cases of hypervascular metastases from renal cell carcinoma were hyperdense (compared to normal pancreatic tissue) in both arterial and venous phases.

In conclusion, although pancreatic metastases are rare, the widespread use of CT and MRI in contemporary medical practice has led to increased detection of such lesions. In oncology patients, accurate diagnosis requires knowledge of patients' history and primary neoplasm, and familiarity with the spectrum of radiologic appearances of secondary pancreatic tumors. Definitive tissue diagnosis is necessary in controversial cases, when precise knowledge of histology will determine or modify appropriate treatment.

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