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Imaging features of pancreatic metastases: A comparison with pancreatic ductal adenocarcinoma

Massimo Galia[a], Domenico Albano[a,*], Dario Picone[a], Maria Chiara Terranova[a], Antonino Agrusa[b], Giuseppe Di Buono[b], Annalisa Licata[c], Giuseppe Lo Re[a], Ludovico La Grutta[a], Massimo Midiri[a]

[a] Department of Radiology, Di.Bi.Med., University of Palermo, Via del Vespro 127, 90127 Palermo, Italy
[b] Department of General Surgery, Urgency and Organ Transplantation, University of Palermo, Via del Vespro 127, 90127 Palermo, Italy
[c] Gastroenterology and Hepatology Section, Di.Bi.Mis., University of Palermo, Via del Vespro 127, 90127 Palermo, Italy

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ABSTRACT

Purpose: To compare imaging features of pancreatic metastases (PM) with those of pancreatic ductal adenocarcinomas (PDAC).
Methods: CT and MR scans of 24 patients with 54 PM and 30 patients with PDAC were reviewed to evaluate the imaging features, which were compared by using a Chi square test.
Results: We found a statistically significant difference between PM and PDAC based on location ($P < 0.001$), margins ($P < 0.001$), arterial enhancement ($P = 0.004$), rim enhancement ($P < 0.001$), pancreatic duct dilatation ($P = 0.01$), common bile duct dilatation ($P = 0.003$), vascular involvement ($P = 0.02$), parenchymal atrophy ($P < 0.001$), peripancreatic fluid ($P = 0.03$).
Conclusion: Imaging features might be helpful to differentiate PM from PDAC.

1. Introduction

Pancreatic malignancies are mainly primary exocrine pancreatic neoplasms, whereas neuroendocrine tumors are much less common [1]. Secondary pancreatic neoplasms are rare, accounting from 2% to 5% of all malignant lesions of the pancreas [2]. As demonstrated by autopsy series, one third of pancreatic metastases (PM) are clinically misdiagnosed as primary malignancies [3]. Indeed, these lesions have no specific symptoms and usually occur in advanced stage neoplasms, when the clinical picture is already severe. Nevertheless, the pancreas may be the only secondary site of a neoplasm, especially in renal cell carcinoma [4], and the early diagnosis of PM may change the treatment and prognosis of the disease. In the differential diagnosis of pancreatic lesions, cancer antigens have limited diagnostic reliability [5].

Imaging modalities such as Computed Tomography (CT) and Magnetic Resonance (MR) are routinely performed during the follow-up of oncologic patients [6–10]. In this setting CT and MR may play a crucial role in the early identification of PM, but their part in the management of PM has been evaluated only on small series of patients [11–19].

Thus, the aims of our study were: (i) to review the CT and MR scans performed on patients with PM at our Institution to describe the imaging features of these lesions; (ii) to compare imaging features of PM with those of pancreatic ductal adenocarcinomas (PDAC).

2. Materials and methods

2.1. Patients

We performed a search of our Institution database to identify all cases of PM found on CT and MR scans from 2006 to 2016. The inclusion criterion was the presence of PM confirmed by histology or by follow-up examinations on patients receiving chemotherapy treatments. We excluded those cases with direct pancreatic invasion by a neoplasm from an adjacent organ. On the basis of this selection, our study population consisted of 24 patients (12 males, 12 females; mean age: 61, range 52–83). Six patients had two CT examinations, 12 patients had three CT examinations, 6 patients had 4 CT examinations. In addition to CT, 13 patients had MR examinations (8 patients had one MR and 5 patients had 2 MRs). Therefore we reviewed 90 examinations (72 CT and 18 MR). Follow-up CT imaging was available in all patients (mean 25 months, range 4–33 months) while follow-up MR imaging was available in five patients (mean 8 months, range 3–17 months). Moreover, we reviewed the CT and MR examinations performed on 30 patients (12 males, 18 females; mean age: 73, range 47–95) with histologically confirmed PDAC.

This retrospective study was approved by the Institutional Review Board with a waiver of the requirement for informed consent.

* Corresponding author.
E-mail address: albanodomenico@me.com (D. Albano).

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Table 1
Distribution of primary malignancies and extra-pancreatic metastases of 24 patients with pancreatic metastases.

Site	Number (%)
Primary malignancy	
Lung carcinoma	8/24 (33%)
Renal cell carcinoma	6/24 (25%)
Thyroid cancer	4/24 (17%)
Breast carcinoma	2/24 (8%)
Merkeloma cancer	2/24 (8%)
Adrenal gland cancer	1/24 (4%)
Soft tissue liposarcoma	1/24 (4%)
Extra-pancreatic metastases	
Lung	18/24 (75%)
Lymph nodes	14/24 (58%)
Liver	12/24 (50%)
Adrenal gland	10/24 (42%)
Kidney	6/24 (25%)
Muscles	6/24 (25%)
Peritoneum	6/24 (25%)
Bone	4/24 (17%)
Pleura	2/24 (8%)
Pericardium	2/24 (8%)
Brain	2/24 (8%)
Skin	2/24 (8%)
Bowel	2/24 (8%)

Table 2
Imaging features of 54 pancreatic metastases and 30 primary pancreatic adenocarcinomas.

Imaging characteristics	Metastases	Adenocarcinoma	*P*-value
Size (range)	2.5 cm (1.2–4.3)	4.7 cm (1–9.4)	
Location			**< 0.001**
Head	6/54 (11%)	17/30 (57%)	
Neck	6/54 (11%)	2/30 (7%)	
Body	20/54 (37%)	6/30 (20%)	
Tail	22/54 (41%)	5/30 (17%)	
Margins			**< 0.001**
Well-defined	21/54 (39%)	0/30 (0%)	
Ill-defined	19/54 (35%)	23/30 (77%)	
Lobulated	14/54 (26%)	7/30 (23%)	
Attenuation on unenhanced CT			0.344
Hypodense	23/54 (43%)	16/30 (53%)	
Isodense	31/54 (57%)	14/30 (47%)	
Hyperdense	0/54 (0%)	0/30 (0%)	
Enhancement on arterial phase			**0.004**
Hypovascular	38/54 (70%)	29/30 (97%)	
Hypervascular	16/54 (30%)	1/30 (3%)	
Enhancement on venous phase			0.057
Homogeneous	15/54 (28%)	3/30 (10%)	
Heterogeneous	39/54 (72%)	27/30 (90%)	
Rim enhancement	22/54 (41%)	1/30 (3%)	**< 0.001**
Calcifications	2/54 (4%)	3/30 (10%)	0.835
Main pancreatic duct dilatation	6/54 (11%)	18/30 (60%)	**0.01**
Common bile duct dilatation	3/54 (6%)	15/30 (50%)	**0.003**
Vascular involvement	7/54 (13%)	18/30 (60%)	**0.02**
Parenchymal atrophy	3/54 (6%)	17/30 (57%)	**< 0.001**
Peripancreatic fluid	4/54 (7%)	13/30 (43%)	**0.003**
Pancreatitis	0/54 (0%)	2/30 (7%)	0.197

2.2. CT protocol

Patients underwent CT scan with a 64-slice CT scanner (Brilliance 64, Philips Medical System, Cleveland, Ohio, USA) and 128-slice CT scanner (Definition AS+, Siemens Healthcare, Forchheim, Germany). All patients drank 500–800 ml of water immediately before undergoing imaging to distend the stomach and duodenum. Unenhanced images of the pancreas initially were obtained by using 3 mm collimation to define the cranio-caudal extent of the pancreas. Then, by using dual head-power automatic injector (Stellant, MedRAD, Pittsburgh, PA, USA) connected to an 18-gauge needle cannula placed in an antecubital vein, a bolus of 100–120 ml of non-ionic iodinated contrast agent (Iomeprol, Iomeron 400, Bracco, Milan, Italy) followed by a saline flushing of 20–30 ml was administered at an injection rate of 3–4 ml/s. For dynamic phase imaging, pancreatic parenchymal, portal and late phases, were performed following a scanning delay of 23 s, 57 s and 163 s, respectively, after the attenuation of a region-of-interest positioned in the aorta at the level of the celiac trunk reached 100 HU. The acquisition parameters were: tube voltage, 120 kV; collimation, 64/128 × 0.6 mm; rotation time, 0.5 s; pitch, 0.6.

2.3. MR protocol

All patients were imaged with a 1.5T-MR imaging unit (Signa Excite, General Electric, Health care, Milwaukee, WI, USA). A dedicated abdominal multichannel surface coil was used for all patients. Imaging protocol included axial pre-contrast images acquired with T2-weighted fast-spin echo sequence (TR/TE, 4000/76 ms; section thickness 5–6 mm) and T1-weighted axial in-phase and out-of-phase gradient-recalled-echo (GRE) sequence (TR/TE, 140/2.2–4.4 ms; section thickness, 5–6 mm). Those examinations performed for the evaluation of pancreatic lesions included two-dimensional and three-dimensional MR cholangiography sequences. Dynamic studies were performed with three-dimensional fat-suppressed T1-weighted GRE sequence (LAVA-TR/TE, 3.8/1.2 ms; FA 12; slice thickness: 4.4 mm; intersection gap 2 mm; FOV: 44 cm; matrix 256 × 256) using a bolus-tracking system. Images were acquired in the axial plane immediately before and after intravenous injection of either 0.1 mmol/kg body weight of gadobenate dimeglumine at 2 ml/s or 0.025 mmol//kg body weight of gadoxetic acid at 1 ml/s through a 20-gage intravenous catheter by means of a power injector (Medrad Spectris Solaris EP MR Injection System; Bayer Healthcare), followed by a 20-ml saline flush at the same injection rate. Scanning delays after automatic detection of contrast bolus were 18, 60, 180 s and 300 s, respectively, for the acquisition of the arterial, portal venous, 3-min, and 5-min phase. The choice of contrast agent was based on availability and personal preferences of the radiologist. Finally, all patients underwent diffusion-weighted imaging sequence as follow: single-shot spin-echo echo-planar with chemical-shift selective fat-suppression technique; scan direction, axial; respiration, non–breath-hold method; b value, 0 s/mm^2, 150 s/mm^2 and 600 s/mm^2 (with diffusion weighted gradients applied in three orthogonal directions); TR/TE, 8000/73 ms; inversion time, 70 ms; matrix, 128 × 64; slice thickness/gap, 5 mm/0 mm; field of view, 40 cm; number of excitations, 6; and acquisition time, approximately 5 min.

2.4. Image interpretation and statistical analysis

CT and MR images were independently reviewed by two radiologists with 16 and 9 years of experience in oncology imaging, respectively. Disagreements were resolved by consensus. Since the histologic confirmation of PM was available in few cases, the morphological and size changes of these lesions detected during treatment was used as proof of their nature. In patients with PM, we assessed the location of primary malignancies and the presence of extra-pancreatic metastases. Then, in both patients with PM and those with PDAC, the following imaging features were evaluated: site, number, size, margins, density/signal intensity of lesions and healthy parenchyma on non-contrast and contrast enhanced images, signal intensity on high b-value DWI images, enhancement pattern on arterial (hypovascular/hypervascular) and venous phase (homogeneous/heterogeneous), rim enhancement, calcifications, main pancreatic duct dilatation (> 2.5 mm), common bile duct dilatation (> 7 mm), vascular involvement, atrophic parenchyma, peripancreatic fluid, pancreatitis. The Chi square test was used to compare the imaging features of PM