# Imaging diagnosis of hepatic metastases of pancreatic carcinomas: Significance of transient wedge-shaped contrast enhancement mimicking arterioportal shunt



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# Imaging Diagnosis of Hepatic Metastases of Pancreatic Carcinomas: Significance of Transient Wedge-shaped Contrast Enhancement Mimicking Arterioportal Shunt

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**Abstract**

We aimed to evaluate the imaging findings of hepatic metastases from pancreatic cancers, especially wedge-shaped enhancement and its etiology.

Dynamic CT and MR images were performed in 87 patients with liver metastases from pancreatic carcinomas, and CT during arterial portography (CTAP) and CT during hepatic arteriography (CTHA) in 51 patients.

Liver metastases were multiple in 84 patients (97%) and solitary in only 3 (3%). In 44 of 87 patients (51%), all liver metastases showed ring-like enhancement compatible with metastatic adenocarcinomas on dynamic CT and/or dynamic MR imaging. In 37 patients, more than one metastatic lesions showed wedge-shaped contrast enhancement on dynamic CT, dynamic MRI and CTHA , and wedge-shaped perfusion defect on CTAP adjacent to metastatic tumors. Six patients showed multiple wedge-shaped enhancement which was initially diagnosed as multiple arterioportal shunts (AP shunts) . However, metastatic tumors appeared within the area of wedge-shaped enhancement and increased in size on follow-up CT and/or MR images. After all, 43 of 87 patients (49%) had AP shunt like contrast enhancement adjacent to liver metastases. Liver metastases from pancreatic carcinomas frequently show transient wedge-shaped enhancement, and should not be misdiagnosed as nontumorous arterioportal shunts.

**Keywords**: Liver metastasis, Pancreatic carcinoma, Arterioportal shunt, CT, MRI

## Introduction

The prognosis of invasive pancreatic carcinoma is quite poor, with an overall median survival time of 8.6 months and a 5-year survival rate of 9.7 % [1]. Most important factor of the prognosis of the patients with pancreatic cancers is liver metastasis. If liver metastases were detected by imaging modalities, surgery for pancreatic cancer would not be indicated. In Japan during past 20 years, 1459 of 9777 (15%) patients initially showed hepatic metastases at the diagnosis of pancreatic carcinoma [1]. Surgery is the only curative treatment for pancreatic carcinoma. However, even if curative resection of the tumor was performed, most patients have a recurrence including higher rate of liver metastases (62%) [2]. High recurrence rate of liver metastases shortly after surgery of pancreatic cancer may imply that liver metastases already exist within the liver at the time of the operation but are two small to be detected by imaging modalities and intraoperative investigation (microscopic metastases) [3].

CT during arterial portography (CTAP) is considered as a very sensitive imaging modality for preoperative work-up of small liver tumors including metastases [3, 4]. Though CTAP had a high sensitivity of small hepatic lesions, the specificity of CTAP is low due to a high rate of false-positive hepatic lesions (pseudolesions) including laminar flow, aberrant venous drainage, and arterioportal shunt etc [5, 6]. Angiography associated CT such as CT during arterial portography (CTAP) combined with CT during hepatic arteriography (CTHA) significant raised the detectability of hepatic tumors and an ability of differentiation between hepatic tumors and nontumorous pseudolesions [7,8] .

Metastatic adenocarcinomas from gastrointestinal tumors including pancreatic carcinomas usually show ring-like contrast enhancement and delayed contrast enhancement of the central portion of the tumors. We have experienced cases of liver metastases secondary to pancreatic carcinomas which showed wedge-shaped contrast enhancement adjacent the lesions and occasionally we have encountered unexpected cases of liver metastases which have been misdiagnosed as pseudolesions because they initially emerged as arterioportal shunts (AP shunts) on dynamic CT, dynamic MR, and angiography associated CT (CTAP and CTHA). So we retrospectively analyzed CT, MRI, and angiographic CT findings of liver metastases from pancreatic carcinomas especially those of the transient wedge-shaped segmental enhancement associated with metastatic lesions.

## Materials and Methods

Patients

This study was based on 256 patients with pancreatic carcinomas diagnosed radiologically and/or pathologically from April 1998 and July 2005 in our institution. In 87 patients (48 males and 39 females, aged 43 to 85 years, mean 67 years), liver metastases were detected by imaging diagnoses (CT, MR, and CT arteriography). Contrast enhanced CT and contrast enhanced MR examinations were performed in all patients, whereas abdominal angiography with CT during arterial portography (CTAP) and CT during hepatic arteriography (CTHA) in 51 patients.

### CT examinations

CT examinations were performed by helical dynamic CT with a HiSpeed Advantage CT scanner or multidetector row CT with a LightSpeed Ultra 16 (GE Healthcare). Precontrast CT and dynamic contrast enhanced CT were done in all patients. Dynamic CT was scanned 35 seconds after iodized contrast medium injection (early phase) and 90 seconds (late phase). The 100-ml of contrast medium was injected at a rate of 3ml/sec with a power injector (Nemoto Kyorindo, Tokyo, Japan). CT images were obtained with 5-mm collimation, pitch of 1.4, and 200 mA for helical CT scanner, and 2.5-mm collimation, pitch 1.5 and 200mA for MDCT.

### MR examinations

MR imaging was performed with a superconducting 1.5-T MR imager (Signa Horizon; GE Medical Systems, Milwaukee, Wis). Breath-hold in phase and opposed phase fast multiplanar spoiled gradient-recalled sequences (FMSPGR; TR 160msec, TE 4.4 msec [in phase], 2.2 msec [opposed phase], flip angle 90°, one acquisition, 256×128 matrix), respiratory-triggered fast SE (FSE) T2-weighted images with frequency selective fat-suppression technique (TR 3333-6666/ 80-90[effective TR/effective TE], echo-train length of 8-12, 256×224 matrix, three acquisitions). The slice thickness was 6 mm with a 2 mm intersection gap for T1- and T2-wighted images. Axial dynamic MR imaging (FMSPGR, 160/ 1.6/90°, 256×128 matrix, one acquisition, fat suppression) with breath holding were performed. Dynamic MR imaging with FMSPGR sequence was acquired before and after intravenous administration of gadopentetate dimeglumine

(Magnevist, Schering, Berlin). The Slice thickness was 6mm with 2mm gap.

**Angiographic examinations**

In 51 of 87 patients with hepatic metastases from pancreatic carcinomas, abdominal angiography with CT during arterial portography (CTAP) and CT during hepatic arteriography (CTHA) was performed for the detection of hepatic metastases. The combination of CTAP and CTHA was performed on an Xpeed CT scanner (Toshiba Medical, Tokyo, Japan). CTAP and CTHA were performed after celiac and superior mesenteric arteriography. For CTAP, 60ml of iodized contrast material was injected with a power injector through the superior mesenteric artery at a rate of 2ml/sec, and CT was performed 25 seconds after the start of the injection. For CTHA, 40ml of contrast medium was injected through common hepatic artery at a rate of 1.8 ml/sec and scan was stared 10 seconds (early phase) and 60 seconds (late phase) after the start of the injection. Scans were obtained with a 5-mm collimation, pitch 1.4 and 200 mA.

Follow-up dynamic CT of the liver was performed in all patients during a 2-to 18-month periods (mean 6.3 months). Follow-up dynamic MR imaging was also performed in selected cases. In equivocal cases of which tumorous and nontumorous transient wedge-shaped contrast enhancement, we diagnosed as liver metastases if apparent tumorous lesions appeared within the area of transient wedge-shaped contrast enhancement at follow-up CT and/or MR examinations.

**Results**

In 87 patients, 84 patients (97%) showed multiple liver metastases and only 3 patients (3%) revealed solitary liver metastasis. In 44 of 87 patients (51%), all liver metastases showed ring-like contrast enhancement on early phase of dynamic CT (Fig. 1) and MR imaging compatible with metastatic adenocarcinomas. Whereas in 37 patients more than one metastatic lesion revealed wedge-shaped or fan-shaped transient contrast enhancement in the early phase of dynamic CT and dynamic MR imaging adjacent to the metastatic liver tumors (Figs. 2-3). These wedge-shaped area surrounding the metastatic lesions showed also wedge-shaped portal perfusion defect on CTAP and wedge-shaped contrast enhancement on CTHA. However, six patients showed multiple wedge-shaped contrast enhancement on the early phase of dynamic CT, dynamic MR imaging and CTHA, and multiple wedge-shaped portal perfusion defects which were initially

misdiagnosed as nontumorous arterioportal shunts (AP shunts) (Figs. 4, 5). However, apparent metastatic lesions appeared within the wedge-shaped enhancement and increased in size on follow-up CT and/or MR images. After all, 43 of 87 patients (49%) had transient wedge-shaped hepatic contrast enhancement mimicking AP shunt adjacent to the liver metastases. Only one patient with solitary liver metastases from pancreatic head carcinoma associated with wedge-shaped contrast enhancement on dynamic CT and wedge-shaped portal perfusion defect on CTAP, underwent hepatic tumor enucleation during pancreaticoduodenectomy. Pathologically, metastatic adenocarcinomas 1.5cm in diameter showed invasion of the portal tract (Glisson's capsule) with tumor thrombi within the peripheral portal venules (Fig.6).

**Discussion**

Several causes of segmental wedge-shaped transient hepatic contrast enhancement have been considered, including portal vein compression and thrombosis, arterioportal shunt, aberrant venous blood supply, hepatic venous obstruction or thrombosis, hepatic abscess, and intrahepatic cholangitis [10, 11, 12]. The segmental transient hepatic enhancement associated with liver metastases secondary to pancreatic cancer has not been described. In our cases, 84 of 87 patients (97 %) showed multiple liver metastases and 44 of 87 patients (51 %) showed peritumoral rim enhancement compatible with adenocarcinoma. In 43 of 87 patients (49 %), more than one metastatic lesions were accompanied by wedge-shaped transient hepatic enhancement on early phase of dynamic studies (dynamic CT, dynamic MRI, and CTHA) and wedge-shaped portal perfusion defect on CTAP. In 6 patients, we initially misdiagnosed as multiple AP shunts because of multiple wedge-shaped contrast enhancement on early phase of dynamic studies and portal perfusion defect on CTAP, but follow-up CT showed typical liver metastases with in the wedge-shaped contrast enhanced areas.

The etiology of this transient enhancement related with liver metastases from pancreatic cancer is unknown. The reason why liver metastases from pancreatic carcinomas have higher frequency of association with AP shunt like wedge-shaped enhancement than that of other gastrointestinal carcinomas is also unknown. We performed pathological examination of one case of liver metastasis associated with wedge-shaped enhancement on dynamic CT and wedge-shaped portal perfusion defect on CTAP. Pathologically, liver metastasis 1.5 cm in diameter showed invasion he portal

tract with tumor thrombi within the portal venules. We supposed that the etiology of transient hepatic enhancement of liver metastasis from pancreatic carcinomas may be correlated with the tumor invasion of portal tract and tumor thrombi of portal venules which causes decreased portal flow and increased hepatic arterial blood flow.

The characterizing imaging features of liver metastases including ring like enhancement with transient wedge-shaped enhancement should be differentiated from liver abscesses [11]. Patients with obstructive jaundice due to pancreatic head carcinomas sometimes accompany intrahepatic cholangitis and liver abscesses. Liver abscesses frequently show ring-like contrast enhancement with transient segmental contrast enhancement on early phase of dynamic CT. The etiology of segmental stain was supposed to be that the portal flow decrease and compensatory hepatic arterial flow increase due to the stenosis of portal venules within the portal tract surrounding the hepatic abscesses [11].

Hepatic abscesses sometimes show double target appearance (three layered structures: central hypodense area indicating abscess cavity, intermediate rim like enhancement indicating abscess wall, and outer hypodense rim indicating secondary edema of surrounding hepatic parenchyma) on the early phase of dynamic CT, and thick ring-like enhancement of the intermediate and outer layer of them on the late phase [12]. Transient segmental contrast enhancement of the hepatic abscesses usually disappear or decrease in size on follow-up dynamic CT after the medication of antibiotic agents. These double target appearance and serial changes of segmental wedge shaped contrast enhancement may a clue to differentiation of hepatic abscesses and hepatic metastases secondary to pancreatic carcinoma.

In our 6 patients, liver metastases initially emerged as wedge–shaped transient contrast enhancement without definite ring-like contrast enhancement indicating hepatic metastases on CT and MRI, and definite metastatic mass lesions appeared within these transient enhanced areas on follow-up dynamic CT. Differentiation between wedge-shaped enhancement of liver metastasis from pancreatic carcinoma and nontumorous AP shunt may be difficult. Nontumorous AP shunts are frequently associated with liver cirrhosis, wedge-shaped, geographic, and nodular in configuration, and sometime show hyperattenuating liner branching structures that represented early opacification of portal veins in the early phase of dynamic CT. In our six cases of AP shunt like enhancement, early opacification of portal vein branches was not seen. So if

portal vein branches were detected within the wedge-shaped enhancement, nontumorous AP shunts would be more likely than tumorous perfusion abnormality.

In patients with pancreatic head carcinoma frequently have obstructive jaundice and occasionally suffered from intrahepatic cholangitis. Intrahepatic cholangitis also shows transient inhomogeneous wedge-shaped enhancement on dynamic CT. The etiology transient wedge-shaped enhancement was thought to be as same as that of hepatic abscess [24]. Transient wedge-shaped hepatic enhancement due to intrahepatic cholangitis is also difficult to differentiate from that of hepatic metastases of pancreatic carcinomas by imaging diagnoses. However, transient hepatic enhancement due to intrahepatic cholangitis and also disappear or decrease in size after treatment of cholangitis like hepatic abscesses [12]. So, follow-up dynamic CT or dynamic MRI would be encouraged to differentiate between intrahepatic cholangitis and hepatic metastasis from pancreatic carcinomas.

If degree of this wedge-shaped contrast enhancement is slight, we would not recognize it itself. In the case of liver metastases emerging as faint wedge-shaped enhancement, angiography associated CT such as CTAP and CTHA depicts hepatic portal and arterial perfusion abnormalities more clearly than dynamic CT and MRI. CTAP and CTHA may be most effective modalities of surveying liver metastases from pancreatic carcinoma, especially emerging as not definite nodular lesions but transient wedge-shaped stain on contrast enhanced CT and MRI.

In conclusion, radiologists should realize that liver metastases from pancreatic carcinomas are frequently associated with transient wedge-shaped contrast enhancement and occasionally, wedge-shaped enhancement is the only radiological finding of lever metastasis, and should not misdiagnose as nontumorous arterioportal shunt.

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## Figure legends

**Fig.1**—74-year-old woman with pancreatic head carcinoma. Early phase of dynamic CT show multiple ring-like contrast enhancement of the liver compatible with metastatic adenocarcinoma.

**Fig.2**—54-year-old man with pancreatic body carcinoma.
A. On the early phase of dynamic CT, liver metastases show ring-like enhancement associated with transient wedge-shaped contrast enhancement (arrow).
B. On the late phase of dynamic CT, wedge-shaped enhancement disappeared.

**Fig.3**—61-year-old woman with pancreatic body carcinoma
Early phase of dynamic MR imaging shows multiple liver metastases with transient wedge-shaped contrast enhancement (arrowhead).

**Fig.4**—64-year-old man with pancreatic head carcinoma.
A, B, C. The early phase (A), late phase (B) of dynamic CT and T2-weighted MR imaging (C) don't show any metastatic lesions.
D, E. CTAP (D) shows multiple wedge-shaped portal perfusion defects and CTHA (E) shows wedge-shaped contrast enhancement (arrowhead). Initially, we diagnosed multiple AP shunts without liver metastases.
F. T2-weighted MR imaging performed 2 month later shows small hyperintense metastases within the area of wedge-shaped contrast enhancement.

**Fig.5**—52-year-old man with pancreatic carcinoma.
A, B. Early phase of dynamic CT shows faint transient wedge-shaped contrast enhancement of the liver (arrowhead).
C, D. Early phase of dynamic MR image shows multiple wedge-shaped contrast enhancement of the liver. Delayed phase of dynamic MR and T2-weighted MR images (not shown) show no abnormality of the liver parenchyma.
E, F. CTAP shows multiple wedge-shaped portal perfusion defects (arrow) in concurrence with the wedge-shaped enhanced areas of the liver.
G, H. Contrast enhanced CT obtained 3 months later shows definite multiple liver

metastases within the areas of AP shunt like transient contrast enhancement.

**Fig.6**—74-year-old woman with pancreatic head carcinoma.
A. Early phase of dynamic CT shows small liver metastasis with surrounding wedge shaped contrast enhancement (arrow).
B. CTAP shows wedge-shaped portal perfusion defect (arrow).
C, D. Photomicrographs show liver metastasis (M) 1.5cm diameter invading the portal tract (arrow) with tumor thrombi within the peripheral portal venules (D: arrowhead).

## Figures

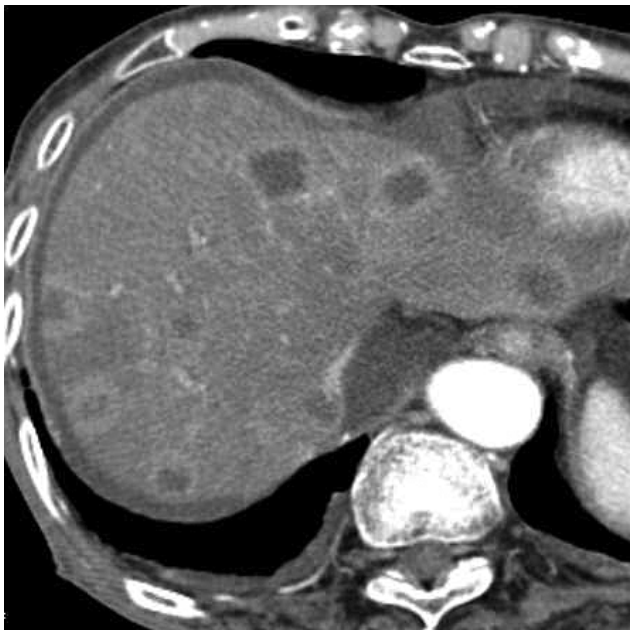
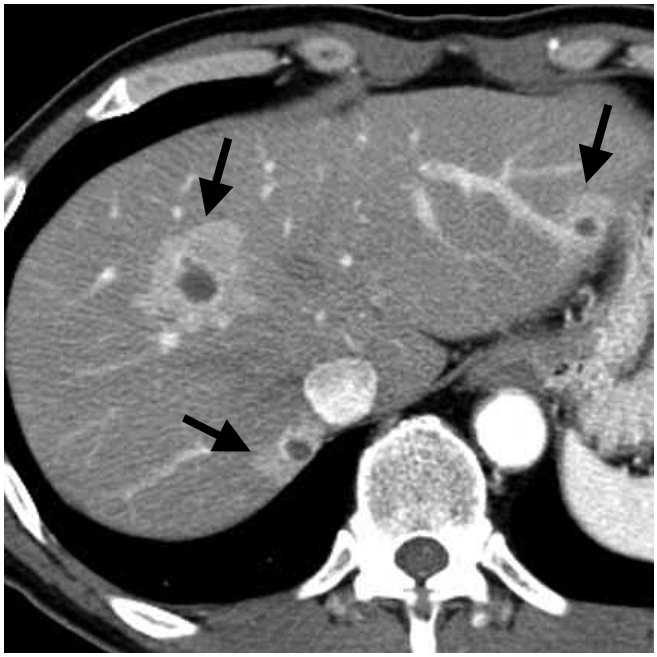


**Fig.1**-74-year-old woman with pancreatic head carcinoma.



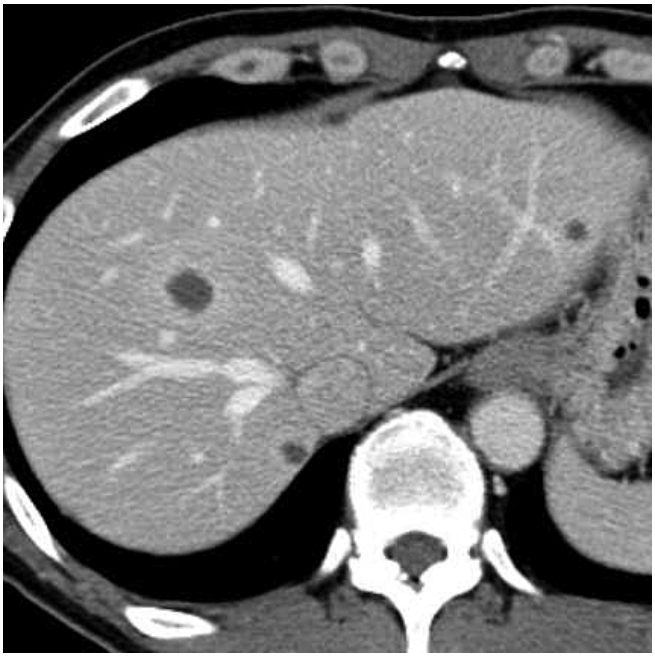


**Fig.2A**—54-year-old man with pancreatic body carcinoma. **Fig.2B**

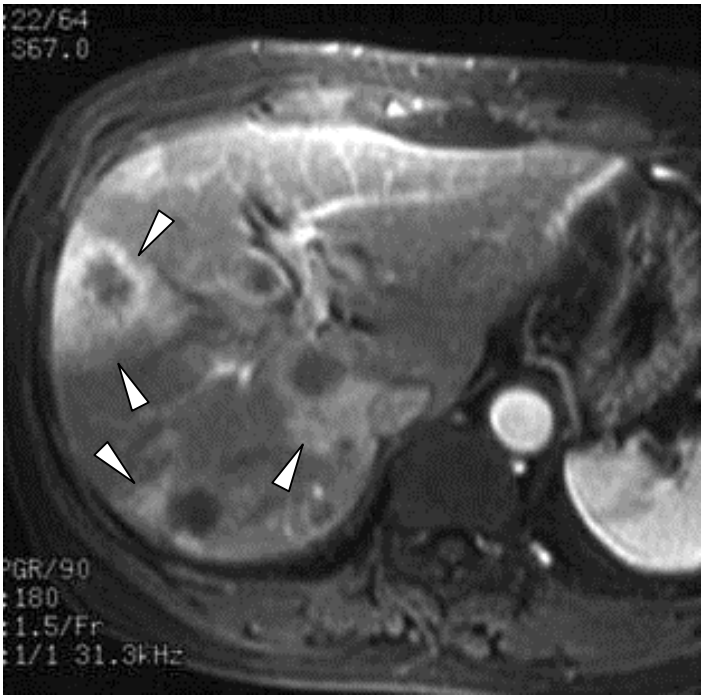
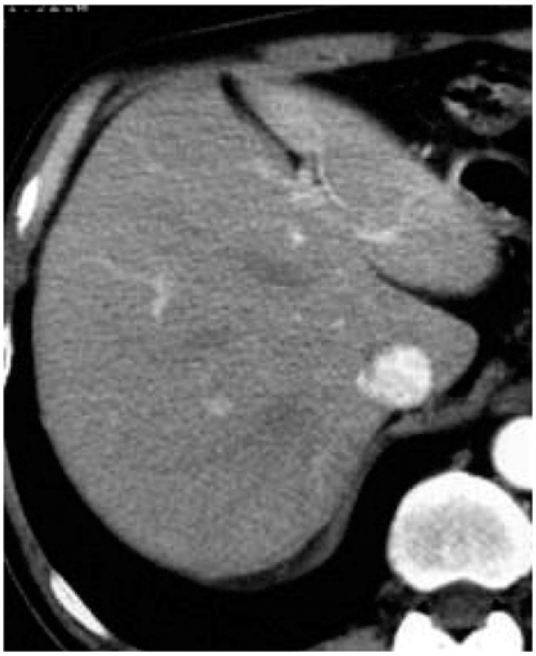



**Fig.3-** 61F pancreatic body carcinoma



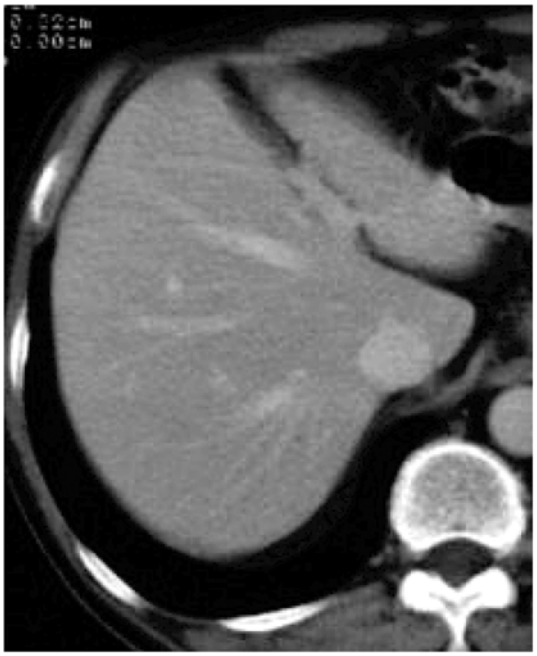


**Fig.4A** -64 M pancreatic head carcinoma **Fig.4B**

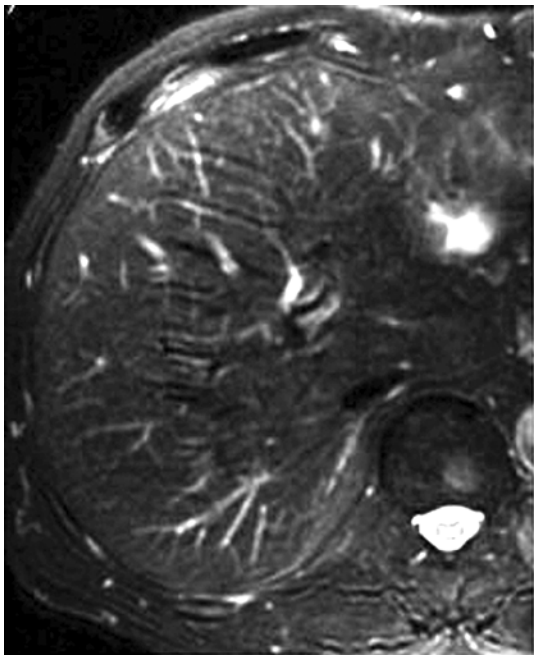


Fig.4C

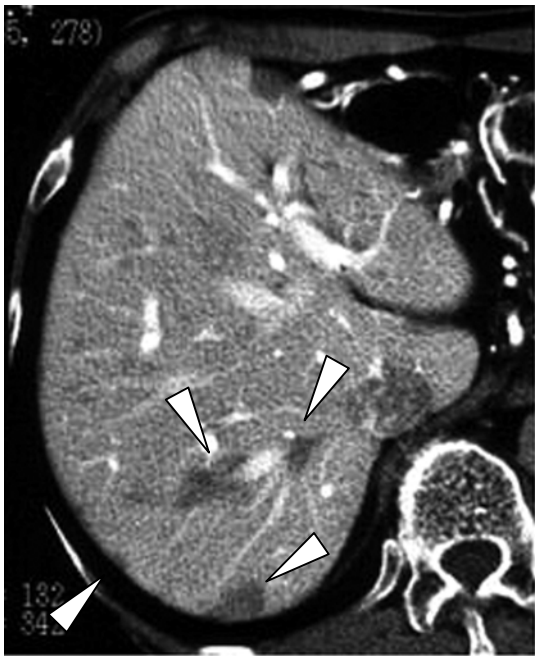



Fig.4D

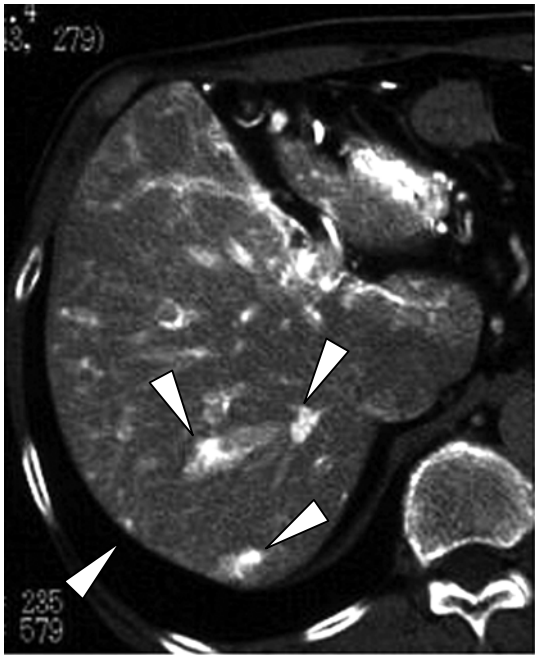



Fig.4E

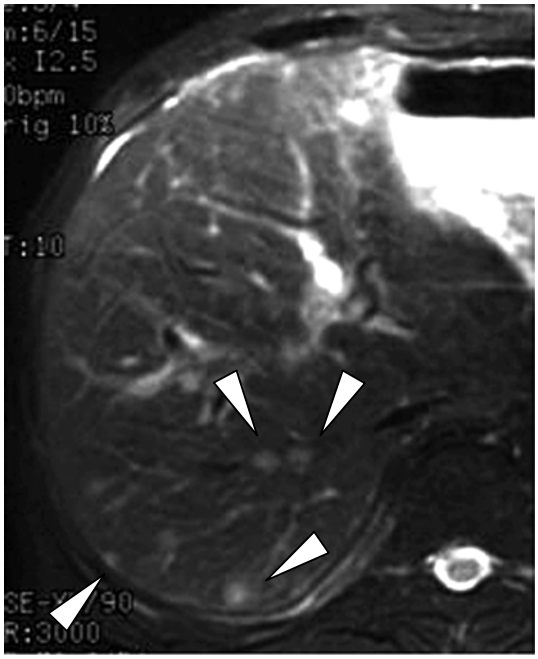
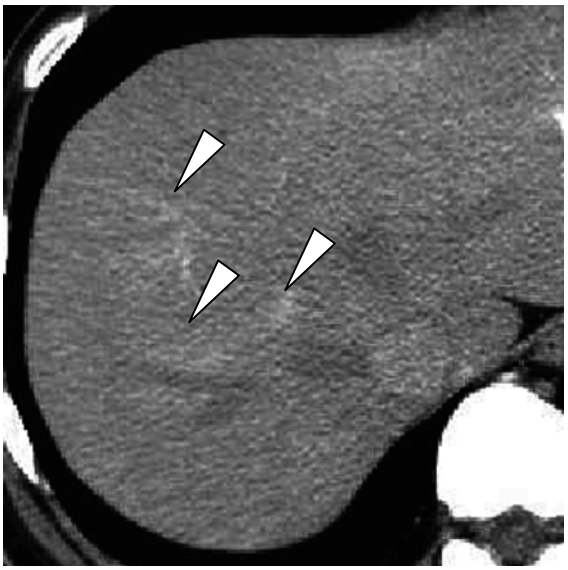



Fig.4F



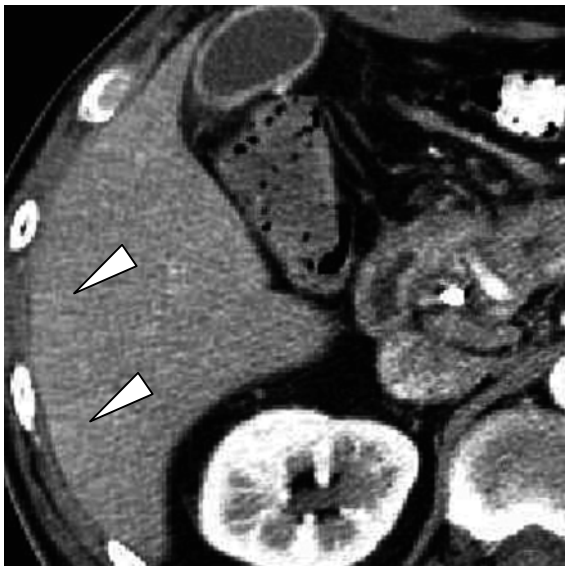
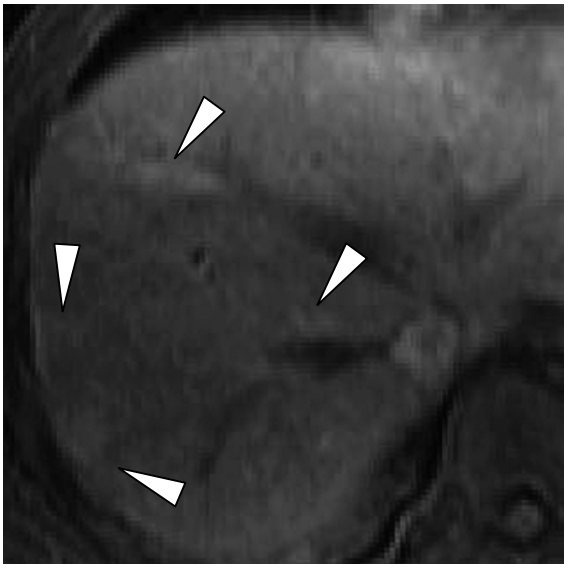


**Fig.5A- 52 M pancreatic head carcinoma** **Fig.5B**



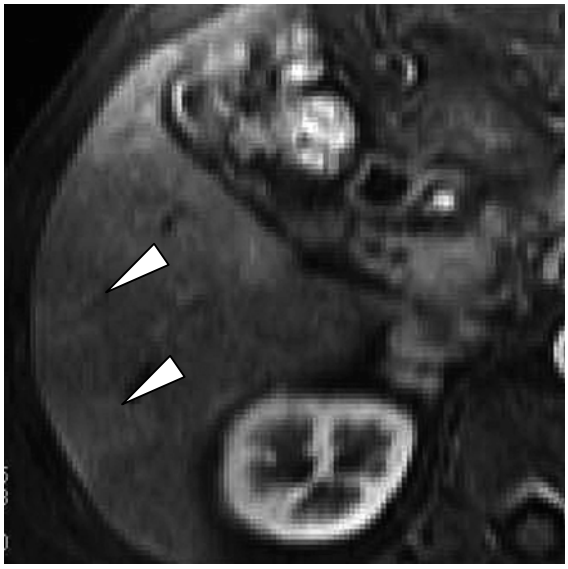
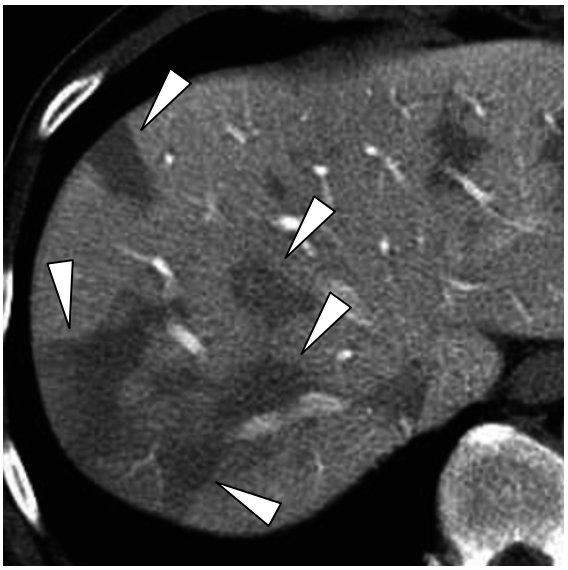


**Fig.5C** **Fig.5D**



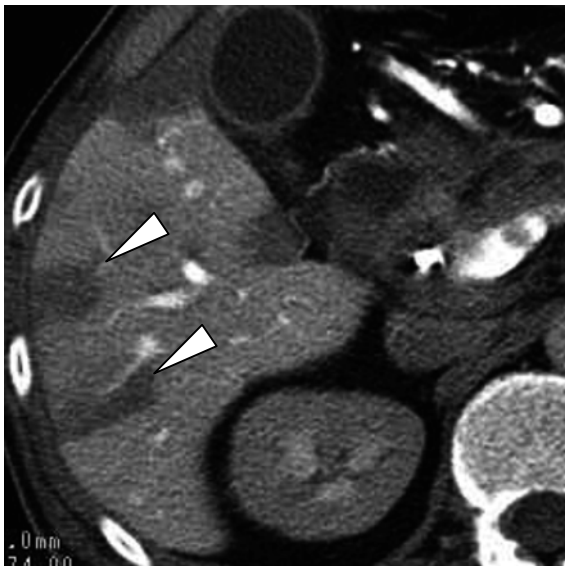
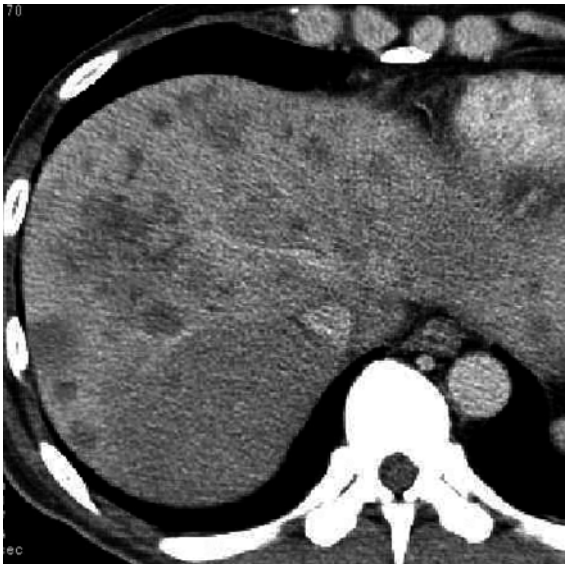


**Fig.5E** **Fig.5F**



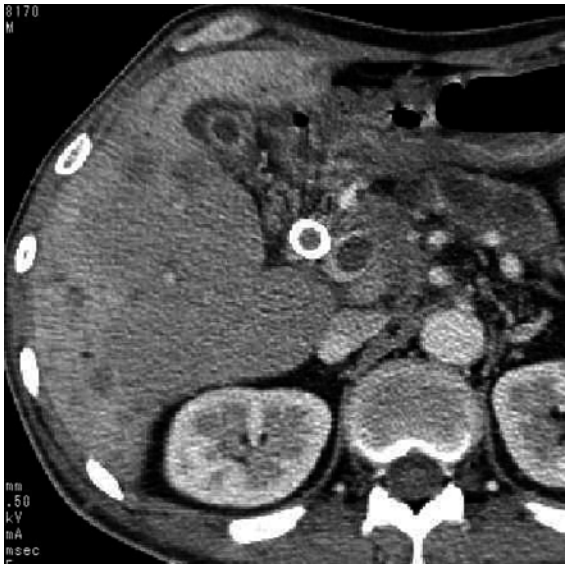
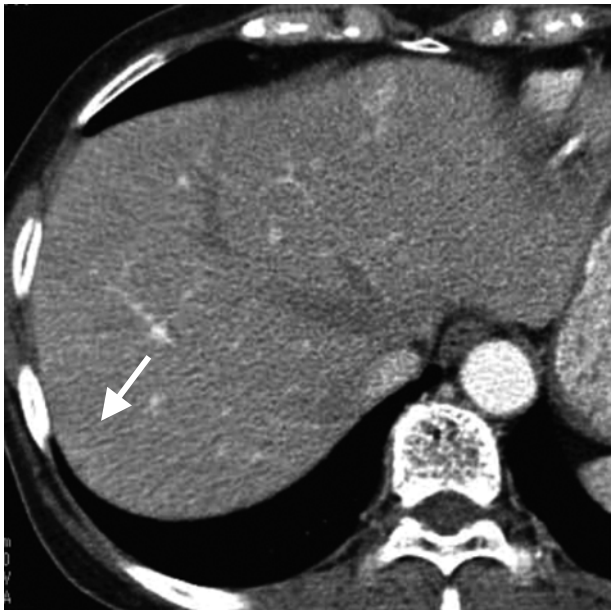


**Fig.5G** **Fig.5H**



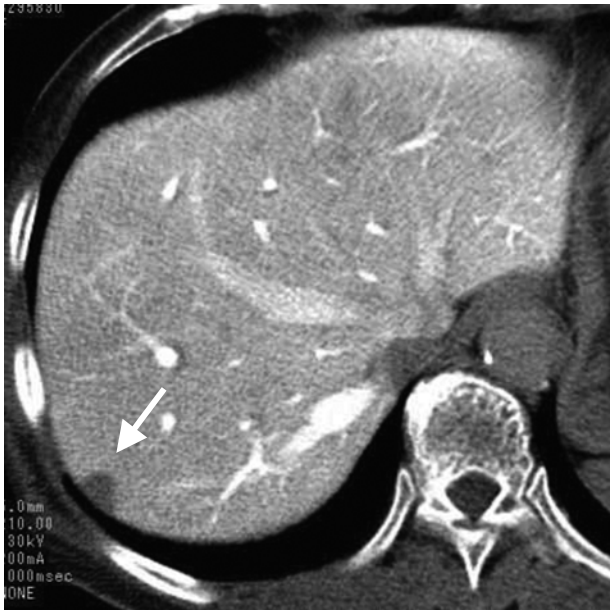
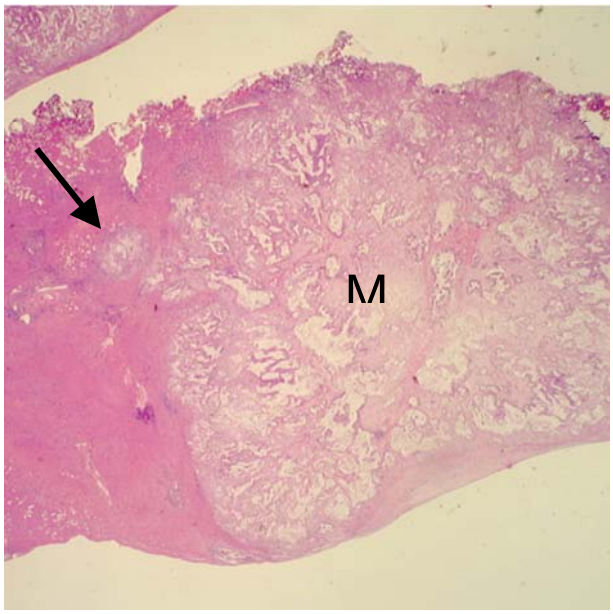


**Fig.6A**- 74F pancreas head carcinoma **Fig.6B**



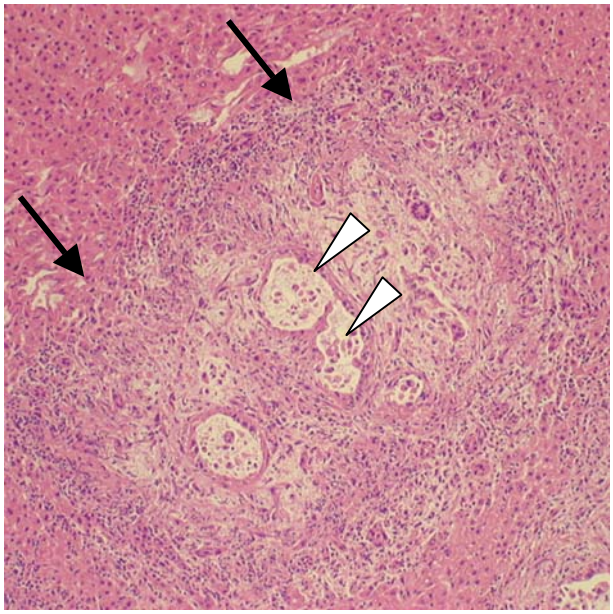



**Fig.6C** **Fig.6D**