Computer-tomographic signs of vascular invasion in tumors of the pancreas

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Learning objectives

• to recognize signs of vascular invasion in pancreatic carcinoma
• to accurately do the T-staging of pancreatic carcinoma based on computer-tomographic findings
• to recognize pancreatic tumors with no local contraindications for curative surgery based on computer-tomographic findings
Background

Pancreatic carcinoma is a tumor with very poor prognosis. Surgery is the only curative technique in pancreatic carcinoma. Unfortunately, at the moment of the diagnosis, most of the tumors are unavailable for curative surgery.

Pancreatic surgery is a technique with a high mortality and morbidity. Zamboni and co appreciate, in a 2007 paper, mortality of the procedure at 5% and morbidity at 40%. In our series mortality is a little bit higher- 10% and morbidity is comparable-40%.

The radiologist has to answer the question which patients are available for pancreatic surgery and which are not. If we classify operable tumors as unoperable (false positive result of unoperable tumor) we refuse the only chance for curative treatment to some patients. If we classify unoperable tumors as operable (false negative result of unoperable tumor) we expose patients to a high-risk surgical procedure.

The CT criteria for unresectability are hepatic metastases, peritoneal carcinomatosis, lymphatic metastases (except the peripancreatic ones), invasion of other organs (excepting the duodenum) and vascular invasion.
Imaging findings OR Procedure details

CT was performed using a 16 slice scanner (Siemens Somatom Emotion 16, Erlangen, Germany). Patients were asked to drink 1000 ml of water 30-45 minutes before the procedure. The abdominal scan was done in the late arterial phase and in the portal venous phase. We used bolus tracking at 120 UH and a delay of 15 seconds for the late arterial phase. The injection rate was at 3-3.5ml/second. We used thin-section scanning and MPR and MIP reconstructions to better deliniate vascular anatomy.

We considered vascular invasion and sign of inoperability if any of the following was invaded: the celiac trunk, the mesenteric artery, the hepatic artery, the splenomesenteric confluence. We also regarded as vascular invasion portal and superior mesenteric vein involvement on a distance longer than 1cm. Venous occlusion of the portal and superior mesenteric vein was also seen as a sign of inoperability. Patients with suspicion of venous invasion on a short distance, in the absence of other surgical contraindications, underwent surgical exploration and, eventually, benefited from vascular reconstructions.

The invasion of the splenic vein, the splenic artery and the gastroduodenal artery were not considered as signs of inoperability.

We considered as signs of vascular invasion:

- arterial stenosis (arteries with diminished caliper or irregular margins- Figure 1)
- vessels embedded in tumor or in contact with the tumor on more than 50% of their caliper (Figure 2, Figure 3, Figure 4)
- the so called "perivascular cuff"- arteries embedded in tumoral tissue at a distance from the tumor. All cases in our series with this aspect had vascular invasion at surgical examination. The aspect can be explained by periarterial lymphatic invasion (Figure 5)
- "periarterial streaks"- fine reticular opacities between the tumor and the vessels with no contact between the vessel and the tumor. In our series we had no patient with this sign as the only sign of unoperability. Valls and co reported 8 cases, 2 of them being proven at surgery as being unresectable. This aspect can reflect either tumor invasion or a peritumoral desmoplastic reaction (Figure 6)
- venous occlusions (Figure 7). Sometimes the presence of dilated collateral vessels signalates the presence of an occluded vein (Figure 8)
- venous stenosis. Veins with diminished caliper or irregular margins. The stenosis of the spleno-mesenteric confluence was considered a sign of unoperability. Stenosis of mesenteric vein or portal vein on a distance longer than 10-15mm was considered sign of unoperability because of the poor prognosis of this patients, even after vascular reconstruction.
procedures (Figure 9). Stenosis and even occlusion of the splenic vein was not considered as a criteria for unresectability

- contact between veins and tumoral tissue. Veins have no muscular wall, so invasion occurs easier than for arteries. Li and all report in their series that 43% of patients with tumoral contact on less than 50% of the circumference of the vein have venous invasion at surgery. We considered operability/inoperability criteria the same as for venous stenosis.

- "tear-shaped superior mesenteric vein". We had two patients with tear-shaped superior mesenteric vein in our series, both considered being unresectable do to signs of arterial invasion. We had no patients with tear-shaped superior mesenteric vein as the only sign of unresectability. Hough reports 13 patients with tear-shaped superior mesenteric vein, all of them with unresectable tumors. Despite that, we consider that if only a tear-shaped superior mesenteric vein is seen on CT, the patient should not be considered as unelegible for pancreatic surgery.

In our series, based on 141 patients with pancreatic carcinoma, 42 of them with tumors considered resectable after CT scanning we had a positive predictive value for unresectability of 100% (no one of the tumors that we described as unresectable and underwent palleative surgery were proven to have, in fact, a resectable tumor) and a negative predictive value for unresectability of 91,5% (four patients were proven intraoperatively to have unresectable tumors and we described preoperatively a resectable tumor. Carcinomatous peritoneal deposits was the reason in two cases and underestimation of venous invasion in the other two).
Fig. 0: splenic artery embedded in a pancreatic tumor, with irregular contours and diminished caliper- suggestive aspect of vascular invasion

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Fig. 0: mesenteric artery embedded by tumor - the aspect is suggestive of vascular invasion

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**Fig. 0:** splenic artery embedded in tumor with a slightly diminished caliper- suggestive aspect of vascular invasion

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**Fig. 0:** superior mesenteric artery surrounded by tumor on more than 50% of his circumference - suggestive aspect of tumoral invasion

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**Fig. 0:** superior mesenteric artery surrounded by tissue at distance from primary tumor. Invasion of the superior mesenteric artery proven at surgery.

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Fig. 0: fine reticular opacities between a pancreatic tumor and the superior mesenteric artery

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Fig. 0: occlusion of the superior mesenteric vein- sign of vascular invasion and unresectability

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Fig. 0: Perigastric collateral circulation in a patient with splenic vein thrombosis due to a pancreatic tumor

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Fig. 0: Splenic vein and spleno-mesenteric confluence with diminished caliper and embedded in tumor - sign of unresectability

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Conclusion

- Multislice CT with MPR and MIP reconstructions gives an accurate view of the great blood vessels and permits us to appreciate if vascular invasion exists in patients with pancreatic tumors.
- Multislice CT has very good negative and positive predictive values for the diagnostic of unresectability of pancreatic carcinoma.
References


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