Pancreatic neuroendocrine tumors and its various radiographic features. Why is it important to distinguish them from adenocarcinoma?

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Learning objectives

• To demonstrate heterogeneous radiological features of pancreatic neuroendocrine tumours (PNT)

• To review how important is to differentiate them from adenocarcinoma of the pancreas.
Background

Pancreatic neuroendocrine tumours (PNT) belong to the group of gastroenteropancreatic neuroendocrine tumours. PNTs are relatively rare tumours, but recently their incidence has been increasing. They usually have better prognosis than adenocarcinoma. Surgery is still the method of choice in terms of treatment. We can also observe the improvement of treatment methods used in case of PNTs based on characteristic features of neuroendocrine cells such as somatostatin receptors expression. Inhibitors of angiogenesis and proliferation of the tumour cells (targeted therapy) and new schemes of systemic chemotherapy are also promising. Neuroendocrine tumors have the ability to produce and secrete peptides and hormones, although many do not present this feature.

Pancreatic neuroendocrine tumors are derived from the islet cells of Langerhans and include insulinomas, gastrinomas, and VIPomas. It can be difficult to characterize a pancreatic neuroendocrine tumor as benign or malignant based upon histology, therefore careful evaluation of local invasive features and distant metastases is important.

Functional tumors which secrete hormones tend to present early as small tumors due to clinical syndrome related to the excess hormone secretion.
Findings and procedure details

Procedure details

In the evaluated group of 130 patients treated in Gastrointestinal Surgery and Transplantology Clinic (years 2012-2016) due to neuroendocrine tumors of the pancreas, we compared histopathological findings with CT / MRI images and summarized the width range measured on most adequate scans, pitfalls and differential diagnoses.

CT Protocol - 64-MDCT scanner :

- **Slice width**: 1 mm.
- **Intravenous contrast**: Iodine-containing contrast agents (>300mg I/L) at an injection rate of 3-4 mL/s.
- **Scan acquisition timing**: arterial phase (at 25-30s) and portal venous phase (at 65-70s).

Findings

Most of neuroendocrine tumors are hypervascular and are isodense to the pancreas on precontrast (non-contrast) CT examinations. Most neuroendocrine tumors tend to be well circumscribed, and rather displacing adjacent structures. PNTs show peak contrast enhancement in the early arterial phase (25-35 s) rather than in late arterial phase (35-45 secs) which is normally used for pancreatic imaging. This is particularly important, because small lesions may be missed in late arterial phase when the tumour will appear isointense/isodense with enhancing pancreatic parenchyma (Fig.1--).

Smaller tumours tend to be homogenous and well circumscribed (Fig. 2,3).

Larger tumours may appear heterogenous and contain areas of necrotic change (Fig.4,5) and they can demonstrate calcifications (Fig.6,7).

PNTs can occasionally manifest as primarily cystic lesions and are distinguishable from other cystic neoplasms by their hypervascular rim (Fig.8).

In MRI examinations these tumors classically demonstrate low signal intensity on T1-weighted images and high signal intensity on T2-weighted images relative to pancreas, but there is a range of signal intensities. Additionally, T1-weighted fat-saturated
sequences have shown to be of value in the identification of these tumors. Similar to CT, these tumors also demonstrate intensive enhancement after the administration of gadolinium - DCE-MRI (dynamic contrast-enhanced MRI) (Fig.9,10,11,12 and Fig.13,14).

CT and MRI both have critical role in suggesting malignant behavior and in the identification of metastatic disease. Features suggesting malignancy include large primary tumor, central necrosis, locally aggressive features such as vascular invasion. PNTs usually have a distinct capsule and they displace rather than invade surrounding structures. They less frequently present with biliary obstruction and tumor related fibrosis, which typically occur in pancreatic adenocarcinomas (Fig. 15).

Liver metastases are most common and have similar appearance to the primary neoplasm, typically presenting as hypervascular lesions with or without central necrosis (Fig.16,17).

The identification of the primary neuroendocrine tumor is important in the treatment of metastatic diseases (Fig.18,19,20,21). Many of the primary lesions are small and identification can be difficult. It may be necessary to perform both CT and MRI in the same case (Fig.22,23,24,25).

The differential diagnosis is necessary and should consider hypervascular metastases e.g. RCC, intrapancreatic splenule and mostly-solid serous cystadenoma.

These are uncommon lesions, without specific features but it is very important to recognize them to prevent unnecessary operation.

Intrapancreatic splenule - especially if is located in the tail of the pancreas (Fig.26,27,28).

Mostly - solid serous cystadenoma (Fig.29,30 and Fig.31- neuroendocrine carcinoma).

Hypervascular metastases - in our material renal cell carcinoma (RCC) (Fig.32).
Fig. 1: PNT in late arterial phase.

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Fig. 2: Small and homogenous tumour.

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**Fig. 3:** Small and homogenous tumour.

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Fig. 4: Heterogenous PNT.

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**Fig. 5:** Large tumour with areas of necrotic change.

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Fig. 7: PNTs can demonstrate calcifications.

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Fig. 6: PNTs can demonstrate calcifications.

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Fig. 8: Primarily cystic PNT.

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Fig. 10: PNT - T2-weighted image(MRI).

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Fig. 11: PNT - dynamic contrast-enhanced MRI (DCE-MRI).

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Fig. 9: PNT - T1-weighted fat-saturated image(MRI).

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**Fig. 12:** PNT - DWI image.

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**Fig. 14:** Neuroendocrine carcinoma - intensive, heterogenous enhancement after the administration of gadolinium (MRI).

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Fig. 13: Neuroendocrine carcinoma - T1-weighted fat-saturated image (MRI).

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Fig. 15: Pancreatic adenocarcinoma.

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Fig. 17: Neuroendocrine carcinoma (the same patient).

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**Fig. 16:** Neuroendocrine carcinoma.

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Fig. 19: Primary neoplasm - neuroendocrine carcinoma.

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Fig. 20: Liver metastases - DWI image.

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Fig. 21: Liver metastases - ADC image.

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Fig. 18: Liver metastases are most common and have similar appearance to the primary neoplasm.

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Fig. 23: Lymph node metastasis - DWI image.

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**Fig. 24:** Small PNT - T1-weighted fat-saturated image (MRI).

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Fig. 25: Small PNT - intensive enhancement after the administration of gadolinium (MRI).

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**Fig. 22:** Small liver metastasis - DWI image.

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Fig. 27: Intrapancreatic splenule - DWI image (MRI).

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Fig. 28: Intrapancreatic splenule.

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Fig. 26: Intrapancreatic splenule - T1-weighted fat-saturated image (MRI).

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**Fig. 30:** Mostly - solid serous cystadenoma

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Fig. 31: Neuroendocrine carcinoma.

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Fig. 29: Mostly - solid serous cystadenoma.

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Fig. 32: Renal cell carcinoma (RCC) metastasis.

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Conclusion

Our observations confirm that smaller tumours of the pancreas tend to be highly vascular and well circumscribed, but larger tumours may appear heterogenous and contain areas of cystic or necrotic change. They can occasionally manifest as primarily cystic lesions and are distinguishable from other cystic neoplasms by their hypervascular rim.

PNTs show peak contrast enhancement in the early arterial phase which is normally used for pancreatic imaging. This is important, because small lesions may be missed in late arterial phase when the tumour will appear isointense with enhancing pancreatic parenchyma, especially when metastatic lesions dominates and the primary lesion is unknown. Features suggesting malignancy in our group include large primary tumor, central necrosis and vascular invasion. PNT usually have a distinct capsule and they displace surrounding structures. As a result they less frequently present with biliary obstruction and tumor related fibrosis, which are a classic mode of presentation for pancreatic adenocarcinomas. The differential diagnosis is necessary and should consider metastases (e.g. RCC), intrapancreatic splenule and mostly-solid serous cystadenoma.


