Learning objectives

To know what brings each imaging technique in the study of solid and cystic lesions of the pancreas and which protocol to use; with a brief overview of the series of our hospital.

Identify the radiological features of adenocarcinoma of the pancreas, which represents up to 90% of pancreatic tumors, and other pancreatic tumors, detailing the diagnostic clues (radiological, epidemiological and clinical) to guide an appropriate differential diagnosis.
**Background**

Diagnostic imaging is an important tool for evaluating pancreatic neoplasms. Pancreatic adenocarcinoma corresponds to approximately 90% of all pancreatic neoplasms in different series. In this review we analyze the most important (radiological, epidemiological and clinical) characteristics of adenocarcinoma itself and the rest of pancreatic neoplasms; being considerably less frequent they are usually not as well known appropriately by general radiologists.

The classification of pancreatic neoplasms are made based on radiological appearance in solid and cystic then subdivided according to their behavior in various imaging tests and depending on the additional tests.

A) SOLID LESIONS OF THE PANCREAS:

- Adenocarcinoma
- Pancreatic Neuroendocrine Tumor
- Solid Pseudopapillary Tumor
- Pancreatoblastoma
- Pancreatic Lymphoma

B) CYSTIC LESIONS OF THE PANCREAS:

- Serous cystadenoma
- Mucinous cystic neoplasm
- Intraductal Papillary Mucinous Neoplasm of the páncreas

C) METASTASES TO THE PANCREAS
Findings and procedure details

In our hospital, the data obtained by puncture aspiration with fine needle and then confirmed with biopsy from January 2009 to September 2014, a total of 189 cases were as follows (Table 1)

A. SOLID TUMORS

1. ADENOCARCINOMA

It corresponds to 90% of pancreatic neoplasms, being the 4th cause of death from cancer with an overall survival rate of 3-4% at 5 years. 80% between 60-80 years old debuts with constitutional symptoms, if the location is cephalic the clinic is early (80% jaundice). Among the risk factors are: smoking, chronic pancreatitis, chemicals (solvents, mothballs), radiation, obesity, genetic predisposition (Sd Peutz-Jeghers, relative of 1st or 2nd degree hereditary pancreatitis, p16 mutations, BCRA. -2, BCRA-1).

The objectives of imaging techniques are approximate localization of the lesion diagnosis and establish local stratification and distance. MSCT is the technique of choice for the diagnosis and establish the radiological TNM providing prognostic value. CT was performed with IV contrast in the arterial phase and venous phase; administered 120 - 150 cc of contrast at a rate of 3 to 5 ml/s; a slice thickness of preferably less than 3 mm.

The arterial phase (between 20-40 second delay) allows optimal visualization of the tumor and peripancreatic arteries; achieving a greater contrast between the hypovascular tumor and normal pancreatic parenchyma enhancement. (Fig. 1) (Fig. 2)

Most tumors have an average size of 3 cm, body and tail tumors show larger size at diagnosis. The portal phase is optimal for detecting metastatic disease in the liver and evaluating peripancreatic veins.

In MRI they have low signal on T1-WI and intermediate - high signal on T2-WI depending on necrotic component, with little enhancement of its solid component after administration of intravenous contrast.

One of the most important data that should translate into the radiology report is whether the tumor is resectable or not. A tumor is unresectable when there are distant metastases, invasion or massive arterial or venous invasion (superior mesenteric or portal vein). (Fig. 3)
The presence of peripancreatic lymphadenopathy is not a definitive contraindication to resection.

2. NEUROENDOCRINE PANCREATIC TUMOR

It represents 5% of all pancreatic tumors, with a peak incidence of 50 years old. Most of them are sporadic, but may be associated with some syndromes (MEN 1, von Hippel-Lindau syndrome, neurofibromatosis type 1 and tuberous sclerosis) in such cases they are usually multiple. They are usually divided into functioning and nonfunctioning. The functioning tumors produce clinical function in excess of the hormone produced, which are usually diagnosed at a younger age than non-functioning.

The small tumors are solid and homogeneous, being more heterogeneous as they increase in size, showing areas of necrosis and calcification. They have a rich blood supply so that enhance avidly during the arterial phase. In MRI they have low signal on T1-WI and intermediate - high signal on T2-WI depending on necrotic component with great enhancement of the solid component in the arterial phase. (Fig. 4)

The small tumors have a homogeneous enhancement (<2 cm), while the larger ones have more heterogeneous enhancement. When clinically suspected it should be performed dual TC (arterial and venous phase) or MRI for the detection and characterization.

The following table shows the main differences between neuroendocrine tumors and its main differential diagnosis, adenocarcinoma (Table 2).

3. SOLID PSEUDOPAPILLARY TUMOR

They are rare tumors, no cases have been found in our review. It constitutes approximately 1-2% of all pancreatic tumors. It is more common in females (9/1: M / H) and young adults with a peak incidence at age 25. They have low malignant potential, with low frequency of metastasis (7-9% of cases with metastases to the liver, omentum and peritoneum); it presents a good prognosis after complete resection. In CT behave like a well-defined lesion with varying degrees of solid and cystic components due to hemorrhagic degeneration that may present with heterogeneous enhancement after administration of CIV its solid component; It is found most frequently in the pancreatic tail, with expansive growth displacing adjacent structures. In MRI they have heterogeneous signal on T1-WI and T2-WI. You may see peripheral calcifications by 30%. Pseudocapsule presents a low density, having low signal CT and MRI (T1-WI and T2-WI), because of its fibrotic component.
4. PANCREATOBLASTOMA

They are rare tumors, no cases have been found in our review, constituting 0.2% of all pancreatic tumors. It is a tumor of childhood, occurring rarely in adults, which is often, however, more aggressive. It is usually associated with elevated #-fetoprotein in 25% of cases. Usually diagnosed when the mass reaches large size (up to 10 cm), since it has a slow growth and the absence of clinical. CT shows a heterogeneous mass with enhancing multilobed septa. In MRI it shows low signal on T1 and high signal on T2, with little enhancement after contrast administration.

5. LYMPHOMA PANCREATIC

In our review, no cases of lymphoma were found. Most often it is a subtype of B-cell non-Hodgkin lymphoma, classified into primary and secondary (by extension of peripancreatic lymph nodes), the latter being the most frequent.

It can present with two morphological patterns:

• Focal: it occurs in the pancreatic head in 80% of cases, being homogeneously hypodense on CT. In MRI has low signal on T1-WI and intermediate signal on T2-WI; with minimal enhancement after intravenous contrast administration in both techniques. No significant dilation of bile duct or pancreatic ductus seen, which helps differentiate it from adenocarcinoma.

• Diffuse: it is infiltrative, producing an enlarged gland and poor definition; it can be confused with symptoms of pancreatitis.

In both morphological types, vascular invasion is rare (unlike adenocarcinoma).

B. CYSTIC TUMORS

Account for 10-15% of all pancreatic neoplasms. There are many different histological types of pancreatic cystic neoplasms that usually present with similar aspect in CT, but overall, serous cystadenomas, mucinous cystic neoplasms and intraductal papillary mucinous tumor constitute 90% of all of them. The importance of trying to differentiate lies in the treatment that will require, because while serous cystadenomas are benign lesions that usually do not require treatment, strain mucinous lesions have malignant potential and surgical removal is necessary.
Before proceeding to describe the most common cystic neoplasms it should be noted that also sometimes some solid pancreatic tumors such as islet tumors and adenocarcinomas, can present cystic or necrotic component that can mimic a cystic tumor imaging; which further complicates the differential diagnosis.

1. CYSTIC SEROUS NEOPLASIA (SEROUS CYSTOADENOMA)

It is a benign tumor, more common in women around the seventh decade of life, and can affect a similar proportion to any side of the pancreas. In 70% of cases it shows a microcyst aspect, more than 6 cysts with usually small diameter of less than 2 cm. Polilobulated, it usually has a fine appearance and enhancement of internal septa. (Fig. 5)

In approximately 30% of cases a central scar, often calcified, which, when present, is considered very characteristic of this type of injury, almost pathognomonic. Not usually associated with ductal dilatation. 20% of cases, cysts are very small and give an aspect "sponge".

In cases in which CT findings are not typical, we can complete the study by MRI, which show multiple bright spotlights on T2-weighted sequences, corresponding with small cysts.

2. MUCINOUS CYST NEOPLASIA (MUCINOUS CYSTADENOMAS / CISTIADENOCARCINOMA)

They are tumors that affect mainly the body and tail of the pancreas and although not communicated with the pancreatic duct, they can sometimes cause partial obstruction. More frequent in women in the 5th-6th decade of life and localized in body-tail of the pancreas. It is generally considered potentially malignant, although some are clearly malignant.

They have macrocystic appeareance. These cysts can have blood or debris inside. Some have internal septa, solid poles and thick walls (better valued at RM), allowing differentiate with serous cystadenomas.

Although the peripheral wall calcification seldom seen on CT, the presence of this finding is highly predictive of malignancy. (Fig. 6)
In over 75% of cases they are symptomatic. When given clinic, this is usually secondary to mass effect on the surrounding structures when they reach large size. For its potential malignancy surgery is indicated.

3. INTRADUCTAL PAPILLARY MUCINOUS NEOPLASM (IPMN)

They are classified according to which pancreatic duct is affected, main, secondary or mixed. It affects in same proportion men and women and is more frequent in the 6th-7th decade of life.

Variant derived from the main duct usually has a different appearance, predominantly solid, but the derivative variant of the secondary duct and mixed (extending from the main duct accessory) are often present as complex cystic masses, sometimes difficult to differentiate from mucinous neoplasms (Fig. 7) (Fig. 8)

Identifying a multilocular cystic lesion communicating with the duct (this is sometimes difficult in CT, being the colangioRM the technique of choice) is highly suggestive of this type of tumor. However, we must not forget that not viewing this communication does not exclude a IPMN. These lesions are considered premalignant so surgery is indicated. The malignant potential is greater in the main duct and mixed types than in the variant involving the secondary duct.

Furthermore, recent studies report that the lesions showing cysts less than 3 cm have low malignant potential, so that you can turn to a less aggressive surgery, or even according to the characteristics of the patient, surveillance.

C. METASTASIS PANCREATIC

It occurs with a frequency of 2-5%, which coincides with the findings in our review (4%), the most frequent primary tumors are renal cell carcinoma and primary lung cancer. In our cases, besides the ones above described, we found metastatic involvement from hepatocarcinoma. These patients often have better prognosis than those with primary adenocarcinoma. Pancreatic involvement is usually solitary, with Both CT and MRI often behaves with similar characteristics to the primary tumor.

In a minority of cases cystic metastases may occur, generally by ovarian carcinomas, which are indistinguishable from the primary cystic tumors. The key thing to suspect metastasis is the presence of a primary tumor in another location.
Table 1: Table 1 Describes the frequency, gender distribution and age of pancreatic tumors

<table>
<thead>
<tr>
<th>TUMOR</th>
<th>Nº (%)</th>
<th>AGE</th>
<th>SEX (M/F)</th>
</tr>
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<tbody>
<tr>
<td>SOLID</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Adenocarcinoma</td>
<td>139 (73)</td>
<td>70</td>
<td>2/1</td>
</tr>
<tr>
<td>- Pancreatic Neuroendocrine Tumor</td>
<td>108 (59)</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>- Solid Pseudopapillary Tumor</td>
<td>21 (14)</td>
<td></td>
<td>1/1</td>
</tr>
<tr>
<td>- Pancreatoblastoma</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Pancreatic Lymphoma</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CYSTIC</td>
<td>44 (23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Serous cystadenoma</td>
<td>15 (8)</td>
<td>65</td>
<td>1/3 (99% F)</td>
</tr>
<tr>
<td>- Mucinous cystic neoplasm</td>
<td>14 (7)</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>- Intraductal Papillary Mucinous Neoplasm of the pancreas</td>
<td>15 (8)</td>
<td>70</td>
<td>1/1</td>
</tr>
<tr>
<td>METASTASIS</td>
<td>6 (4)</td>
<td>50</td>
<td>1/1</td>
</tr>
</tbody>
</table>
Fig. 1: Adenocarcinoma. Double duct sign secondary to pancreatic mass (yellow arrow = common hepatic duct / blue arrow = cystic) (not shown). Ectatic pancreatic duct.

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Fig. 2: Adenocarcinoma. (A) Postcontrast arterial phase CT shows a homogeneous hypovascular mass of 2.5 cm in uncinate process. Vesicular distension. (B) Postcontrast portal phase CT (same patient) shows dilatation of the intrahepatic bile duct.

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Fig. 3: Adenocarcinoma. Postcontrast arterial phase CT (A) and portal phase (B). Hypovascular solid mass in pancreatic body that reduces the caliber of splenic artery and vein (arrows), suggestive of vascular infiltration of them. (C) Axial T1-weighted contrast-enhanced with fat-suppressed sequence in venous phase (same patient as A and B) shows a hypovascular mass in the pancreatic body, better defined than in TC.

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**Fig. 4:** Neuroendocrine tumor. Axial T1 and T2-weighted MR images and T1-weighted contrast-enhanced with fat-suppressed sequence in arterial phase (A, B and C) shows 1.6 cm nodule in uncinate process, hypointense on T1-WI, hyperintense on T2-WI, with intense enhancement in the arterial phase.

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<table>
<thead>
<tr>
<th></th>
<th>NEUROENDOCRINE TUMOR</th>
<th>ADENOCARCINOMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tumor primario</td>
<td>Hypervascular</td>
<td>Hypovascular</td>
</tr>
<tr>
<td>Density</td>
<td>Heterogeneous with cystic areas and / or necrotic, +/- calcifications</td>
<td>No calcifications</td>
</tr>
<tr>
<td>Growth</td>
<td>Expansive</td>
<td>Infiltrative</td>
</tr>
<tr>
<td>Effect on adjacent organs</td>
<td>Compressive</td>
<td>Infiltrative</td>
</tr>
<tr>
<td>Dilated ducts (bile duct, pancreatic duct)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Metastasis</td>
<td>Hypervascular</td>
<td>Hypovascular</td>
</tr>
</tbody>
</table>

**Table 2:** Main differences between neuroendocrine tumors and adenocarcinoma

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Fig. 5: Cystic serous neoplasia. Axial T1 and T2-weighted (A and B) and coronal T2-weighted (C) MR images. It shows cystic lesion in pancreatic head / uncinate process, hypointense on T1 images and hyperintense on T2, no enhancement was seen after contrast administration (not shown). Due to its small size of the cysts and morphology it was suggestive of serous tumor.

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**Fig. 6:** Mucinous cyst neoplasia. Postcontrast portal phase CT shows hypodense mass of 3.4 cm in pancreatic tail with liquid attenuation values, suggestive of cyst. It has a peripheral calcification. Biopsy shows mucinous neoplasm. The presence of calcification is highly predictive of malignancy.

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**Fig. 7:** Intraductal papillary mucinous neoplasm. Axial T1-WI (B) and T2-WI (C) MR images. It shows pseudonodular cystic in pancreatic body, which is in close contact with the pancreatic duct. Biopsy showed that this was a Branch-duct IPMN.

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**Fig. 8:** Intraductal papillary mucinous neoplasm. Axial T2-WI and MRI cholangiography images (A and B), shows dilatation of the main pancreatic duct with maximum caliber of
9 mm caliber seen. The biopsy showed that it was a Main-duct IPMN. Atrophic pancreas appearance and simple cyst in the right hepatic lobe are also seen.
Conclusion

Pancreatic tumors are a heterogeneous group of entities that include primary-secondary tumors, which may present themselves with variable appearance on imaging tests, such as tumors with different degrees of solid and cystic component; of which the most common is adenocarcinoma. Given a pancreatic tumor, tests that best characterize them are CT and MRI with IV contrast with arterial and venous phase.

On a day to day it is not always possible to make an accurate diagnosis, however as radiologists we should make a presumptive diagnosis, for which we must not only rely on radiological features, but also clinical and epidemiological.

Our review broadly consistent with those reported in other series, adenocarcinoma being the most frequent tumor (59% of cases), and neuroendocrine tumor the second most common solid tumor (14% of cases). No cases of pseudopapillary tumor, pancreatoblastoma (more common in pediatric age) or lymphoma were found.

In our review it draws attention the increased of proportion of diagnoses of cystic tumors compared to other series, probably because cystic pancreatic lesions are increasingly identified due to the widespread use of CT and MR.


