How you can save the patient from Whipple procedure

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Learning objectives

Our main objectives in this educational exhibit are:

1. Explain the embryology of the ventral and dorsal pancreas and its importance in the diagnosis of pancreatic head lesions.
2. Highlight the importance and role of optimum protocols with multiphasic MDCT and MRI in the evaluation of the pancreatic head lesions.
3. Describe the CT and MRI findings of pancreatic head carcinoma tumors.
4. Illustrate the specific CT and MRI findings of benign pancreatic head lesions.
Background

Pancreatic carcinomas are among leading causes of death worldwide. The only hope for a potential cure, especially in adenocarcinomas, in these patients is pancreoduodenectomy, the so-called Whipple procedure. Despite increased experience and better post-operative care Whipple procedure is still a cause of major morbidity and sometimes, even, mortality. Patients may be afflicted with several early and late complications including, but not limited to, infection, hemorrhage, pancreatitis, biliary obstruction, pancreatic fistula and delayed gastric emptying.

Pancreas is a retroperitoneal organ that lies in the anterior pararenal space. Embryologically, pancreas first appears in the 5th week of gestation in the form of two outpouchings, ventral and dorsal buds, from the endodermal lining of the duodenum. Ventral pancreatic bud later rotates around the duodenum and forms the posterior portion of pancreatic head-- mainly uncinate process--. whereas the anterior portion of the head, body and tail of the pancreas are derived from the dorsal pancreatic bud. Microscopically, the portion of the pancreas that is derived from the ventral pancreatic bud is more cellular, while, the rest of the pancreas that derives embryologically from the dorsal pancreatic bud is less compact and contains more fat. For the sake of clarity and easy understanding we will use the term "ventral pancreas" for the pancreatic tissue that derives from ventral pancreatic bud and the term "dorsal pancreas" for the pancreatic tissue that derives from dorsal pancreatic bud.

Pancreatic head is also a common site for the benign diseases of the pancreas and failure to correctly diagnose these lesions pre-operatively may lead patients to unnecessary Whipple surgery. Awareness of the underlying embryology may be helpful in the correct pre-operative identification of these benign lesions. Anatomic variants should also be kept in mind since they may mimic pancreatic masses.
Findings and procedure details

Multiplanar and multiphasic scans with reformatted images are of crucial importance for accurate diagnosis.

Normal pancreatic parenchyma has soft tissue density on CT and appears hyperintense on T1-weighted fat suppressed images due to its high protein content. After IV contrast injection, the healthy pancreas should demonstrate homogenous enhancement. T2 weighted images are helpful for the evaluation of pancreatic ductal system and its related pathologies.

Pancreatic cancer

Pancreatic adenocarcinoma is the most common pancreatic cancer and pancreatic head is the most common location. They appear hypointense on non-contrast T1 weighted fat-suppressed images with variable patterns of contrast enhancement in the post-contrast images. Abrupt and acute pancreatic duct obstruction ("cut off" sign) and associating downstream parenchymal atrophy are the hallmark imaging features of the pancreatic adenocarcinomas. Diffusion weighted imaging may be helpful for location of occult lesions that could not be identified in conventional sequences and concomitant pathologically enlarged lymph nodes in the neighboring anatomic planes should be meticulously searched for, as they represent locally advanced tumor. The location of the tumor, whether located in the ventral or dorsal pancreas, is an important point to consider, since the lymphatic drainage and clinicopathological features may vary accordingly.

Anatomic Variants and Anomalies

The most common congenital anatomic variant of pancreatic duct is the pancreatic divisum. The condition arises from abnormal fusion of ventral and dorsal pancreatic buds. In this anatomic variation the major and minor pancreatic ducts fail to fuse and open separately into the duodenum (Fig. 1). Although it's generally clinically silent, recurrent pancreatitis may be observed in some cases. In those cases, pancreatic head may appear enlarged and heterogeneous after contrast injection which may easily be confused with pancreatic malignancies, especially in the absence of other typical imaging features of acute pancreatitis.

Annular pancreas is another relatively common anatomic variant of the pancreatic head, which occurs due to abnormal rotation and the fusion of the pancreatic buds. In this anomaly, the descending portion of the duodenum is completely encircled by the pancreatic head and may simulate a pancreatic mass, especially to the inexperienced eyes (Fig. 2).
Duodenal duplication cysts and diverticula may be also be easily mistaken for a cystic neoplasm in select cases (Fig. 3). Choledochal cysts are another anatomical anomaly which should be considered among the mimickers of pancreatic head masses.

**Focal Fatty Infiltration/Sparing**

Focal fatty infiltration commonly involves the anterior part of pancreatic head, while sparing the dorsal aspect and uncinate process of the pancreas with a sharp demarcation line. In these cases, normal pancreatic contours are preserved and the pancreatic and biliary ducts appear non-dilated. It may be especially difficult to differentiate focal fatty infiltration from pancreatic head masses on CT as they both appear as hypodense areas. This diagnostic confusion may be resolved by using MRI since it is more accurate in differentiating fat from normal pancreatic parenchyma. On MRI, fatty infiltration areas appear iso-mildly hyperintense on in-phase images while they appear hypointense, due to signal drop-out, on out-of-phase images which is not an imaging feature of any pancreatic malignancy (Fig. 4).

Similar to focal fatty infiltration, focal fatty sparing is also commonly visualized in the anterior aspect of the pancreatic head, while the ventral pancreas is generally spared.

**Focal Pancreatitis**

Despite the fact that CT is the main workhorse for the evaluation of patients with clinical suspicion of acute/chronic pancreatitis, MRI was demonstrated to be more sensitive in the depiction of early phase findings of especially in early stages of acute pancreatitis. In the early stages of acute pancreatitis CT might appear normal while non-contrast fat suppressed T2 weighted and dynamic contrast enhanced T1 weighted images in MRI may demonstrate the focal increased intensity and delayed/decreased enhancement of the parenchyma (Fig. 5). Peripancreatic edema and fluid collections can be seen in T2 weighted images as well as on CT. MRI may also be more sensitive for the detection of the underlying reason of acute pancreatitis by demonstrating the pancreatic ductal abnormalities or the choledochal pathologies.

**Focal Autoimmune Pancreatitis**

Autoimmune pancreatitis (AIP) is a relatively recently defined clinicopathologic entity. Microscopically, lymphocytic infiltration and fibrosis are the main features and it is classified as a component of systemic IgG4 related disease. Imaging findings may simulate acute pancreatitis but several imaging features may help for the correct diagnosis. It is also not uncommon for AIP to simulate focal pancreatic head mass with associated biliary dilatation. In chronic cases delayed parenchymal enhancement,
secondary to underlying fibrosis, may be encountered. Segmental strictures of the pancreatic duct, visualized in MRCP images, may favor the diagnosis of AIP (Figs. 6, 7).

**Pancreatic Lymphoma**

Secondary involvement of pancreas in patients with lymphoma is a common clinical entity. On the other hand, primary pancreatic lymphoma is a very rare clinical situation and accounts for less than 0.5% of all pancreatic tumors. Differential diagnosis might be really difficult, or sometimes impossible. However, there are some imaging findings which may favor the diagnosis of primary pancreatic lymphoma over much more common pancreatic adenocarcinoma. Large masses greater than 5 cm, homogenous contrast enhancement of the mass and encasement of the peripancreatic vessels with preserved patency rather than stenosis or occlusion, as well as, marked hypermetabolism on PET-CT scans might suggest primary pancreatic lymphoma over pancreatic adenocarcinoma (Fig. 8).

**Serous Microcystadenoma**

Serous microcystadenomas usually affect women of advanced age. Characteristically, they manifest as large cystic masses, may contain a central stellate scar, enhancing septa and calcifications. Typically the cysts do not communicate with the pancreatic duct, which is a useful point for narrowing the list of differential diagnosis. The location is another helpful clue that may lead to the correct diagnosis as pancreatic head is the most common location of these tumors (Figs. 9, 10).

**Lipoma**

Mesencyhmal tumors account for nearly 1% of all pancreatic tumors and lipomas are among the least common of these entities. Lipomas appear as lesions that harbor macroscopic fat, which can easily be detected with both CT and MRI, with no enhancement after IV contrast injection (Fig. 11). The macroscopic fat content demonstrates significant signal loss in fat suppressed images on MRI and appears homogenously hypointense. Among the differential diagnosis of macroscopic fat containing pancreatic lesions, liposarcoma and teratoma should also be considered. Imaging features are straightforward for lipoma and any intervention is usually not warranted.
Fig. 1: Pancreatic divisum with focal pancreatitis. 50 year old male presents with abdominal pain. (A, B) Focal pancreatitis of ventral pancreas characterized by increased signal intensity on fat suppressed T2 weighted images (A) and slightly decreased signal intensity on T1 weighted images (B). (C) Pancreatic duct (open arrow) and choledoch (white arrow) open separately to the duodenum consistent with pancreatic divisum.

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Fig. 2: Annular pancreas. Pancreatic parenchyma surrounding the descending portion of duodenum on contrast enhanced axial CT images in two different patients.
Fig. 3: Duodenal diverticula. 51 year old female patient presents with abdominal pain to emergency room. Axial images of contrast enhanced portal venous phase CT after oral contrast administration demonstrates a hyperdense round lesion in the ventral pancreas secondary to pooling of oral contrast material in its lumen. The underlying reason of abdominal pain was found to be perforated appendicitis (not shown).

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**Fig. 4:** Focal fatty infiltration. 55 year old male with a suspected pancreatic head malignancy on CT. Contrast enhanced axial CT image (A) demonstrates a focal hypodense lesion in the pancreatic head. On MRI, the lesion is mildly hyperintense on in-phase images (B) and shows signal-drop on out-of-phase images (C), typical for focal fatty infiltration.

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**Fig. 5:** Focal pancreatitis of ventral pancreas. 50 year old male patient. (A) Increased signal intensity in the ventral pancreas on T2-weighted fat suppressed axial image. There was no evident pancreatic necrosis or peripancreatic fluid collection in contrast enhanced images (not shown). (B) On follow up image the abnormal signal intensity in the ventral pancreas has regressed.

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Fig. 6: Focal autoimmune pancreatitis. 48 year old male patient presents with abdominal pain and increased amylase levels. (A) On contrast enhanced axial CT image shows an edematous and enlarged ventral pancreas. (B, C) Increased signal in the ventral pancreas on T2 weighted fat suppressed images with more conspicuous contrast enhancement, compared to the other parts of the pancreas, in the same location on T1-weighted images. (D) Multisegmental stenoses in the main pancreatic duct on MRCP images consistent with chronic inflammation.

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Fig. 7: (A-F) Follow up scans showed the regression of the signal increase in the ventral pancreas accompanying parenchymal atrophy in the ventral pancreas.

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Fig. 8: Primary pancreatic lymphoma. 72 year old female referred for pancreatic mass biopsy. (A) A bulky lesion with increased signal intensity on T2 weighted images is seen. The lesion surrounds the vessels but there is no stenosis or occlusion. (B, C) There is a focal area of fat infiltration within the mass, characterized by hyperintensity on the in-phase image (B) with signal drop on the out-of-phase image (C), a finding not expected with adenocarcinomas. (D) Mesenteric extension of the mass was also noted. (E,F) On diffusion weighted images, marked diffusion restriction was noted within the lesion. Image guided percutaneous biopsy confirmed lymphoma. (G-I) The patient underwent chemotherapy and the mass is completely resolved on control MRI 1 week after the start of chemotherapy.

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**Fig. 9:** Serous cystadenoma of pancreatic head. 57 year-old male patient with persistent abdominal pain in the epigastric region. (A,B) T2 weighted axial images with and without fat suppression demonstrate a distinctive hyperintense lesion with thin linear septa and numerous millimetric cystic spaces. (C) No solid enhancing component or central satellite scar was detected on T1-weighted images. (D) There is no visible communication between cysts and the main pancreatic duct on MRCP image.

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**Fig. 10:** Serous cystadenoma of pancreatic head, follow-up. (A) T2 weighted axial image with fat suppression 16 months later shows no significant change in the size or contours of the lesion. (B) Again no contrast enhancement was visualized on T1-weighted images.
Fig. 11: Lipoma at uncinate process. 53 year old female on routine follow up for breast carcinoma. Contrast enhanced axial CT image demonstrates the lesion containing macroscopic fat.

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Conclusion

Pancreatic malignant tumors are among the important causes of death. Benign lesions located at the pancreatic head may mimic malign lesions and may cause diagnostic confusion. Optimal protocol selection with MDCT and MRI is of utmost importance for the correct diagnosis and differentiation benign lesions from the malignant ones. Correct diagnosis may spare a patient from an unnecessary Whipple procedure, which has a significant morbidity and, even, mortality. Fat content, diffusion weighted imaging characteristics and contrast enhancement patterns may be helpful for accurate diagnosis. Embryological development of the pancreas may also provide important diagnostic clues to the correct diagnosis and familiarity with this phenomenon may also provide insight to the practicing imaging specialists.
Personal information

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References


