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Clinical Radiology
The Royal College of Radiologists

Recommendations for cross-sectional imaging in cancer management

Pancreas

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Contents

Clinical background

Pancreatic cancer constitutes 2.9% of all cancers in the UK.[1] The most common histological type is ductal adenocarcinoma (PDAC) accounting for over 90% of all pancreatic malignancies, with a predilection for the head and neck of the gland. Patients often present sporadically with obstructive jaundice, although a link has also been reported with new onset or rapidly deteriorating type 2 diabetes.[2] Ampullary and distal common bile duct carcinomas may be indistinguishable from pancreatic head ductal adenocarcinomas but, despite having separate pathological staging systems, the therapeutic issues and work-up are identical.

Traditionally, the standard of care for PDAC considered resectable at diagnosis is surgery, in which all macroscopic tumour is excised. However, the prognosis following resection remains poor with five-year survival in the UK at only 6.9% (advanced stage at presentation and early spread along perineural pathways, resulting in high early recurrence rate).[3] Recent advances in chemotherapy and stereotactic body radiation therapy (SBRT) offer a new strategy of neoadjuvant treatment followed by surgery with the aim of downstaging tumours, increasing likelihood of negative resection margins and improving overall prognosis.[4] Results are encouraging and there is significant interest in this approach, although its exact role and timing of any subsequent surgery remain to be fully established. Chemotherapy and radiotherapy also have palliative roles in advanced cases.

Diagnostic pathways

Diagnostic staging should be performed before bile duct stent insertion. Artifact from both plastic and metal stents can obscure small tumours on both computed tomography (CT) and endoscopic ultrasound (EUS). There is also a risk of developing pancreatitis following biliary drainage, which can obliterate normal fat planes and reduce the ability to assess tumour-vascular involvement.

CT and magnetic resonance imaging (MRI) are similar in their ability to evaluate local tumour extent with both tending to underestimate disease extent. CT offers superior vascular assessment in terms of identifying significant vascular stenoses that can impact surgery and allows multiplanar reformatting, with full staging of any distant spread all in one test. Resection can be considered in the absence of metastatic disease or involvement of the visceral arteries or the portal venous structures. In selected cases, short segments of the superior mesenteric or portal vein may be resected.

CT and MRI are poor predictors of lymph node involvement. Nodes of normal size can harbour micro-metastases, while enlarged nodes maybe reactive. The sensitivity of MRI, positron emission tomography-CT (PET-CT) and EUS for detection of involved nodes is <30% and not significantly better than CT alone.[5] Detection of distant nodal involvement is more crucial as locoregional nodes are routinely removed during surgery. Liver metastases, which are often small, and peritoneal metastases preclude resection.

Percutaneous biopsy is not always necessary in potentially resectable PDAC if a confident diagnosis can be made radiologically, but is usually performed before chemotherapy. Biliary drainage is the major palliative procedure with either some form of biliary stenting or surgical bypass; some patients may also require duodenal stent insertion for relief of gastric outlet obstruction. EUS is of value in problem-solving with small tumours, may allow biopsy without breaching the peritoneum and may enable coeliac axis neural blocks to be done for pain relief.

Tumour marker carbohydrate antigen CA19–9 has been widely used in PDAC diagnosis and, despite limitations such as elevation in non-malignant causes of biliary obstruction, is still the current standard serum tumour marker.

Neuroendocrine tumours and cystic neoplasms of the pancreas are less common and have a more favourable prognosis. Neuroendocrine pancreatic tumours may present as a consequence of a hyperfunctioning syndrome (often small tumours), as a non-functioning mass or as part of multiple endocrine neoplasia type 1 (may be multiple tumours).

Who should be imaged?

If a pancreatic neoplasm is suspected, either clinically or as a consequence of a prior investigation, diagnostic CT using a dual-phase pancreas protocol should be performed.[6] Pancreatic neoplasms may present with non-specific symptoms and therefore may be detected on CT undertaken as a more general survey abdominal scan. If the tumours are advanced then recall for a dedicated pancreas protocol staging CT is often unnecessary as it will not alter management.

Staging objectives

- To evaluate whether the pancreatic pathology is inflammatory or malignant.
- To determine evidence of involvement of the visceral arteries and portal venous system (including any aberrant vessels).
- To identify metastatic deposits in the liver, peritoneum and lungs.
- To detect lymph node enlargement.
- To identify bile duct and duodenal obstruction.
- To decide preoperatively if neoadjuvant treatment would be of benefit.
- To determine the size of the tumour where chemoradiotherapy might be used in the palliative setting (usually tumours <5 cm in diameter).

The TNM staging system from the American Joint Committee on Cancer (AJCC) is of limited value for treatment planning in PDAC. Instead, a three-stage classification system for resectability has been established with the most widely accepted classification from the National Comprehensive Cancer Network (NCCN).[7] Tumours are classified as resectable, borderline resectable or unresectable:

- Resectable – usually treated with primary resection surgery; however, definition varies across classification systems and continues to evolve
- Borderline resectable – technically resectable, albeit often at the expense of vascular reconstruction and carry a high risk of positive resection margins and, therefore, poorer prognosis
- Unresectable – if tumours have metastasised or are locally advanced (local vascular spread that precludes complete resection).

Staging

Ultrasound is the primary investigation in identifying biliary obstruction as the cause of jaundice. CT using a pancreas protocol is the investigation of choice if a pancreatic neoplasm is suspected and for restaging following neoadjuvant therapy.[6]

EUS, and its related techniques such as EUS-guided fine-needle aspiration, has had a significant impact on the clinical evaluation of pancreatic cancers, particularly for problem-solving and in the detection and characterisation of small pancreatic lesions. CT using low kVp technique, dual-energy/spectral imaging or MRI can also improve the detection of isoattenuating PDAC and can be performed if necessary, depending on local availability/expertise (to improve depiction of the primary tumour and help determine relationships with blood vessels including contact without vessel deformity, which may alter management). Multiplanar thin-section reconstructions are essential in evaluation of vascular involvement. MRI is also useful for problem-solving if there are indeterminate features on CT or to clarify the nature of indeterminate liver lesions detected on CT.

CT technique

- Oral administration of 750 ml of water over 30 minutes as a negative contrast agent to fill the stomach, duodenum and proximal small bowel.
- 100–150 ml of intravenous iodinated contrast medium injected at 3–4 ml/sec (ideally using weight-based volume).
- Multidetector computed tomography (MDCT) (dual-phase acquisition) commenced at 35–40 seconds (pancreatic phase) and 65–70 seconds (portal venous phase) after onset of injection. If using bolus tracking, which is preferable to optimise the vascular phases, then 18 seconds delay abdomen followed by a further 25 seconds delay abdomen and pelvis (to include chest if tumour suspected radiologically).
- MDCT images should be acquired at 0.625–1.25 mm slice thickness in the pancreatic phase and maximum of 3 mm in the portal venous phase with coronal reformats.

Values of CT dose index ($CTDI_{vol}$) should normally be below the relevant national reference dose for the region of scan and patient group (see chapter on risks of radiation exposure).

MRI technique

A period of fasting (four hours pre-examination) or a manganese-containing negative oral contrast agent such as pineapple/blueberry juice are helpful to reduce the fluid signal from the upper gastrointestinal tract, which can obscure normal structures on magnetic resonance cholangiopancreatography (MRCP) sequences. A phased array surface coil is used to maximise the signal-to-noise ratio.

Protocol for imaging of pancreatic tumours

Sequence	Plane	Slice thickness	Principal observations
T2W 2D and 3D MRCP	Coronal oblique	40 mm and 1 mm respectively	Highlight and assess hepatic and pancreatic ducts
T2W	Axial/coronal oblique*	4 ± 1 mm	Assess cystic lesions/ducts
T1W with water excitation/fat suppression	Axial	4 ± 1 mm	Assess pancreatic parenchyma
T1W with contrast medium	Axial/coronal oblique*	1.5–2.5 mm	Visualise tumours and relationship to local vessels
Diffusion weighted imaging (with suggested b values of 50, 200, 500 and 750)	Axial	5 mm	Identify malignant pancreatic lesion and liver metastases

* Dependent on the location of the tumour (see text).

- With the dynamic gadolinium-enhanced MR series, the optimal plane depends on the location of the tumour to better assess biliary and vascular involvement. The pancreatic and portal venous phase acquisitions are best acquired using an oblique coronal plane for pancreatic head tumours followed by an axial acquisition. For tumours of the body and tail and for neuroendocrine tumours, the initial acquisitions are best obtained axially. This is less critical if 3D techniques are employed because an isotropic dataset can be obtained that can be reconstructed in any plane.
- A delayed axial acquisition through the pancreas at ten minutes is of value in neuroendocrine tumours.

PET-CT

Fluorodeoxyglucose positron emission tomography-CT (^{18}FDG PET-CT) has been reported to provide significant incremental diagnostic benefit in addition to MDCT in the diagnosis and staging of pancreatic cancer, preventing futile resection in 20% of patients.[8] ^{18}FDG PET-CT should be offered to people with localised PDAC on MDCT who will be having cancer treatment (surgery, radiotherapy or systemic therapy with a view to potentially curative treatment thereafter).[6]

On ^{18}FDG PET-CT scans, acute pancreatitis and pancreatic carcinoma both show increased ^{18}FDG uptake, and it is therefore not possible to differentiate these conditions, although there may be some value to PET imaging when distinguishing chronic pancreatitis from carcinoma. It can also be useful in selected patients with suspected recurrence where other imaging is equivocal or negative.

Follow-up

Routine imaging after surgery is not indicated as palliative chemotherapy is generally only considered when there is symptomatic recurrent disease. Follow-up imaging is conducted when there is clinical evidence of disease recurrence. Follow-up is performed to assess response to chemotherapy (±radiotherapy) and is, therefore, performed at a frequency to correspond with the chemotherapy regimens.

Tips

- Dual-phase pancreas protocol CT is the examination of choice in patients with suspected PDAC for initial staging and following neoadjuvant therapy.
- EUS, dual-energy CT or MRI can be useful for problem-solving depending on local availability/preference.
- Coronal or sagittal reformatted CT images can be very useful to evaluate vascular involvement. More complex reconstructions such as curved planar reformats are occasionally helpful.

References

1. Office for National Statistics. *Cancer statistics registrations, England 2017*.
2. Maitra A, Sharma A, Brand RE *et al*. A prospective study to establish a new-onset diabetes cohort: from the Consortium for the Study of Chronic Pancreatitis, Diabetes, and Pancreatic Cancer. *Pancreas* 2018; **47**(10): 1244–1248.
3. Pancreatic Cancer UK. www.pancreaticcancer.org.uk/statistics/ (last accessed 9/6/20)
4. Ducreux M, Cuhna AS, Caramella C et al. Cancer of the pancreas: ESMO clinical practice guidelines for diagnosis, treatment and follow-up. *Ann Oncol* 2015; **26**(Suppl 5): v56–v68.
5. Tseng DS, van Santvoort HC, Fegrachi S *et al*. Diagnostic accuracy of CT in assessing extra-regional lymphadenopathy in pancreatic and peri-ampullary cancer: a systematic review and meta-analysis. *Surg Oncol* 2014; **23(4):** 229–235.
6. NICE. Pancreatic cancer in adults: diagnosis and management. NICE guideline published 7 February 2018. www.nice.org.uk/guidance/ng85
7. National Comprehensive Cancer Network. *NCCN clinical practice guidelines in oncology. Pancreatic adenocarcinoma*. Version 2.2016. Fort Washington, PA: National Comprehensive Cancer Network, 2016.
8. Ghaneh P, Hanson R, Titman A *et al*. PET-PANC: multicentre prospective diagnostic accuracy and health economic analysis study of the impact of combined modality 18fluorine-2-fluoro-2-deoxy-d-glucose positron emission tomography with computed tomography scanning in the diagnosis and management of pancreatic cancer. *Health Technol Assess* 2018; **22(7)**.

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