Ultrasound in the investigation of the pancreas and the biliary tree

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Ultrasound (US) is a central imaging tool in the investigation of pancreaticobiliary problems. This article explores common clinical scenarios and the role US plays in patient care. In particular, we will consider how the strengths and weaknesses of US impact on its place in the pathway.

US is capable of detailing anatomy and pathology in excellent spatial resolution. Its intrinsic high contrast resolution between fluid and solid is a key advantage in examining the pancreaticobiliary system. It is patient centred, with a human face on the end of the scan. This allows the operator to both scan and correlate with patient symptoms to increase diagnostic confidence. There is no risk from radiation and access is not limited by allergy, renal impairment or exposure to magnetic fields. However, while it can analyse a specific target in detail and in real time, its limited field of view can cause problems when there are multiple and complex abnormalities.

Pancreas
In some respects, the pancreas is a difficult organ for US. It has a complex shape and relations, lies deep within the abdomen and is surrounded by segments of potentially gas-filled gut which can obscure it. However, when good views are obtained, it can identify serious pathology exquisitely.

Technique
In an abdominal survey, try to find the pancreas first. If it is not seen, then you have opportunities later in the examination to try again. One manoeuvre that can help is described here: With the patient supine, press the probe transversely and firmly in the epigastrium. Ask the patient to puff out their tummy, keep pressing. Ask the patient to relax. Keep pressing. Frequently the pancreas will move into view.

Appearance
The pancreas can have varying degrees of reflectivity in normality that can make pathological parenchymal changes difficult to identify (figure 1).

Cancer
Pancreatic malignancy is the single most important diagnosis to make in reference to the pancreas. Pancreatic adenocarcinoma is seen as an irregular hyperechoic mass, often associated with ductal dilatation (pancreatic, biliary or both) (figure 2). Inflammation can cause similar masses, but identification of such an abnormality should typically prompt specialist referral and further investigation.

Cyst
Pancreatic cysts are typically seen as an incidental finding. ‘Simple’ pancreatic cysts are rare while post inflammatory cysts are common. However, it is recognised that a significant proportion of cysts will turn out to be cystic neoplasms of uncertain malignant potential. Management of these is tricky and a sensible clinician should individualise follow-up of these to the overall patient picture.

Pancreatic duct dilatation
The isolated dilated pancreatic duct (>2-3mm) can be caused by malignancy and this finding should prompt a close search for an obstructing mass. Identification of ductal irregularity suggests a diagnosis of chronic pancreatitis. Intraductal papillary mucinous neoplasm is an uncommon pathology that can present as focal cystic abnormalities in the pancreas, pancreatic duct dilatation or a combination of both. While these diagnoses can be made with US, full characterisation of the underlying disease process is typically needed with another form of cross-sectional imaging.

Inflammation
US is challenging in the context of acute pancreatitis. While it is possible to diagnose inflammatory changes within the pancreas and complications of the disease, it does not do so reliably and CT is the main imaging modality used in the context of severe acute pancreatitis. Early access to US is advised in cases of pancreatitis, but this is chiefly to identify gallstones in the gallbladder and duct which can help point the aetiology and triage patients into early cholecystectomy.

Changes of chronic pancreatitis can also be seen (gland atrophy, irregular ductal dilatation, calcification) but again, these changes are usually better seen and globally assessed with CT.

Gallbladder and biliary tree
Intrinsic contrast between fluid and soft tissue gives US fantastic strength in identifying pathology in the biliary system.

Technique
Biliary tree
Mostly, we are looking for duct dilatation. To assess for intrahepatic biliary dilatation, sweep through the liver looking for the double-barrelled shotgun sign of dilated ducts paralleling portal vein radicals. Caution should be used in making this diagnosis in patients with cirrhosis when hypertrophied hepatic artery branches can cause a similar appearance (application of colour Doppler solves this problem).

Assessment of the extrahepatic biliary system (common hepatic duct, cystic duct and common bile duct) is usually achievable with perseverance and optimal patient positioning (figure 3). Supine views may be adequate, though moving intercostal or sub-costal with the patient turned on their left side can be helpful, and is frequently the optimal way to assess the gallbladder. Movement of the patient into this position can also provide a dynamic assessment of gallbladder contents, helping differentiate mobile stones from solid or adherent tissue.
Gallstones

Gallstones are extremely common in both symptomatic and asymptomatic patients. Stones, sludge and debris are readily identified on US making it the ideal modality for investigating unexplained right upper quadrant pain. In the acute setting, US can show complications such as cholecystitis, gallbladder perforation and pericholecystic abscess (figure 4). US allows placement of a cholecystostomy drain in appropriate cases.

Common duct dilatation

Identification of the common duct (CD) can be straightforward, although deciding if the duct calibre is pathological may not be so easy. CD calibre increases normally with age. A commonly used rule of thumb is to take 6mm and below as normal duct calibre with 1mm added to this for every decade of life above 60. However, this is not a specific rule, with a proportion of patients with CD calibre above this having no significant underlying pathology. Duct calibre can also increase in the context of previous biliary disease, although the relationship with preceding cholecystectomy is not certain. This is clearly disappointing for instances where you see a dilated CD in someone with their gallbladder out, but are not convinced there is any actual biliary obstruction.

A dilated CD should prompt a thorough search for the cause, tracing the duct down through the head of the pancreas to the ampulla. Identification of ductal calculi can triage patients towards stone extraction, while a stricture or pancreas mass will have completely different implications. However, it is reasonably commonplace to find a dilated CD without demonstrable cause. In symptomatic patients and/or those with an obstructive pattern of liver function test (LFT) derangement, the potential need for further investigation is obvious. However, in patients where a dilated common bile duct is seen as an incidental finding, then management is less clear cut. Missing a tumour is a disaster, but over-investigation of normality carries an intrinsic morbidity. The most powerful tool we have in the scan room is access to previous imaging (of any modality). Demonstrating that the dilatation is longstanding is a reassuring feature implying there is no progressive underlying abnormality. If there is no LFT derangement or symptoms, it is difficult to know how further, potentially invasive, investigation will make a patient feel better. In the absence of previous reassuring imaging, the clinical team will have to make a judgement based on the overall clinical picture to plan further management. From the US operator’s perspective, having a low threshold for discussing these patients with colleagues in the department will help optimise the advice given in the report in these challenging cases.

Gallbladder polyps and cancer

Tumours of the gallbladder provide yet more diagnostic difficulty. Adherent stones can masquerade as polyps. Differentiating the two is important because polyps can become cancerous. The larger the polyp, the higher the risk of malignant potential. Contrast enhanced US can play a role in troubleshooting this diagnosis (figure 5).

Cancers and chronic inflammation are also problematic for US, not least because a severely diseased gallbladder may be unrecognisable as a gallbladder. The differentiation between an inflammatory mass and a tumour mass on any imaging modality can be difficult. Both pathologies are associated with gallstones and can cause irregular wall thickening and a reaction in the adjacent liver parenchyma. Malignancy can also develop within a gallbladder affected by chronic cholecystitis. Tissue diagnosis (biopsy) or a period of follow-up may be the only way to confirm the diagnosis.

Conclusion

Ultrasound is a valuable diagnostic tool that can enhance the patient pathway as the first-line modality to assess the patient with suspected biliary and pancreatic disease. It is very helpful in the investigation of right upper quadrant pain and the jaundiced patient, triaging patients into the optimal management pathway. Therefore, if you can offer an accessible and responsive US service then you can make a real impact into improving patient care.
Figure 3
Occasionally the common duct can be seen almost in its entirety on a single view. More commonly it has a curvilinear course and is assessed piecemeal.

Figure 4
Acute cholecystitis with adjacent abscess. There is complete loss of the posterior gallbladder wall (arrow) not appreciated on previous CT. The patient proceeded to US-guided cholecystostomy.

Figure 5
Contrast enhanced US of an incidentally found gallbladder polyp confirming the diagnosis. Histology confirmed tubular adenoma.