Laparoscopic examination of the abdominal cavity will, at most, improve this yield by 10%. The effect of endoscopic ultrasound, peritoneal washings, bone marrow biopsy and PET scanning have yet to be fully evaluated. It is cost-effective to limit the investigations to state-of-the-art CT scanning and accept a slightly higher rate of inoperable cases which can be managed by surgical palliation.

With selection the surgical outcome should be a mortality of under 5% and a 5-year survival of 20% for duct cell carcinomas. The quality of life for patients undergoing pancreatoduodenectomy is good and their initial recovery period is no longer than 3 months before achieving an acceptable normalization of life. Adjuvant chemotherapy improves survival by 10%. Radiotherapy does not improve survival and it may even be harmful.

Conclusion

The surgeons' view of pancreatic carcinoma is that the diagnosis should be made early, the investigations should be undertaken expeditiously and the investigations limited to helical CT scanning. For those patients with an inoperable tumour a biopsy is appropriate. Operative mortality should be low and the quality of life following recovery from resection good.

Key points

(1) Incidence of disease far more common in the elderly
(2) Histological type of great importance prognostically
(3) Early diagnosis essential
(4) Operability determined by high quality imaging
(5) Resection associated with a <5% mortality and a 20% 5-year survival

Further reading

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Carcinoma of the pancreas: detection and staging using CT and MRI

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Our ability to diagnose pancreatic carcinoma has improved substantially over the past 20 years, owing to major advances in pancreatic imaging, including the development of US, CT and MRI. Despite these advances, however, the prognosis of patients with pancreatic cancer remains dismal. The overall 5-year survival rate is only 3%[1], although the 5-year survival rate for patients who undergo pancreatic resection is reported to be approximately 20%[2–4]. Because of the very poor prognosis of patients with pancreatic carcinoma, many physicians take a nihilistic approach to its diagnosis and staging. It is important to keep in mind, however, that a large percentage of patients with pancreatic cancer who undergo laparotomy for possible curative resection are found to have unresectable disease. Thus, optimization of pre-operative imaging is important in order to reduce the percentage of patients who are unnecessarily subjected to laparotomy.

CT has become established as the primary initial imaging method for both detection and staging of suspected pancreatic carcinoma. Most studies have found that CT is highly reliable when it demonstrates features indicating that a tumor is unresectable[5,6]. The positive predictive value (PPV) of a diagnosis of unresectability with helical CT has ranged from 92% to 100%[7–11]. Helical CT is less reliable, however, for predicting that a tumor is resectable (PPV=76–90%)[7–11]. Nevertheless, this represents a substantial improvement over prediction of resectability with conventional CT (PPV=45–72%)[12–14]. Limitations of CT include: poor ability to demonstrate small hepatic or peritoneal metastases; inability to demonstrate microscopic

lymph node metastases; and inability to differentiate inflammatory from neoplastic lymph node enlargement.

Optimized technique is essential to achieve the highest predictive values for resectability and unresectability. The CT data should be acquired helically using a rapid IV contrast medium injection rate (e.g. 4–5 ml/s)[15,16] and appropriate scan timing during the pancreatic parenchymal phase of enhancement[17,18]. Images should be acquired with thin collimation ($\leq$3 mm) to optimize in-plane spatial resolution, and overlapping reconstructions are recommended for producing high quality multiplanar and 3-dimensional images when needed. Curved planar reformations through the pancreatic duct or peripancreatic vessels can be useful for displaying the imaging findings to the surgeon[19]. Two-dimensional and 3-dimensional volume-rendered images of the peripancreatic vessels are not routinely necessary for staging but can provide useful information in some cases[20,21]. Such CT angiographic images can be useful in pre-operative planning, especially if variant celiac axis, hepatic artery or superior mesenteric artery anatomy is present.

State-of-the-art MRI using breath-hold imaging sequences, a phased-array torso coil and dynamic gadolinium enhancement is equivalent to CT for demonstrating small pancreatic carcinomas and providing accurate staging information[22]. A recent study found dynamic gadolinium-enhanced MR imaging to be superior to dual-phase helical CT in the pre-operative assessment of resectability of pancreatic carcinoma[9]. However, in that study, the helical CT imaging technique was not optimized. As with CT, the MR imaging technique must be optimized in order for MR to provide accurate pre-operative staging information. The limitations of MR imaging are similar to those of CT. A potential advantage of MR is its superior tissue contrast compared with CT. In addition, heavily T2-weighted pulse sequences can be used to perform MR cholangiopancreatography (MRCP)[23,24]. Although its spatial resolution is less than that of endoscopic retrograde cholangiopancreatography (ERCP), an advantage of MRCP over ERCP, in addition to its noninvasiveness, is its ability to demonstrate the portions of the pancreatic and bile ducts proximal to obstructions and high-grade strictures. In addition, MRCP is useful for the demonstration and evaluation of mucin-producing pancreatic tumors[25–27].

In the hands of some investigators, transabdominal color Doppler ultrasonography has been shown to have an accuracy similar to those of CT and angiography for diagnosing arterial and portal venous invasion by pancreatic carcinoma[28,29]. Nevertheless, ultrasonography continues to play a secondary role in the detection and staging of pancreatic carcinoma at most institutions. Endoscopic ultrasound (EUS) is also highly accurate for predicting portal venous invasion and is considered by some investigators to be the most accurate test for imaging pancreatic cancer[30]. EUS is particularly useful for detecting small masses in the head and body of the pancreas and for directing transluminal biopsies of these masses. Limitations of EUS are that it is not widely available and that it provides inconsistent visualization of the pancreatic tail. FDG-PET may have a potential role in the diagnosis of pancreatic carcinoma in patients with an indeterminate pancreatic mass, but currently does not play a significant role in pancreatic carcinoma staging.

Although criteria for unresectability vary among surgeons, imaging features that generally indicate unresectability include vascular invasion, lymph node metastases beyond those in the immediate vicinity of the pancreas, and distant metastases. Metastases most commonly involve the liver or peritoneum.

Several recent studies have evaluated the accuracy of CT findings of vascular invasion (of the portal vein, superior mesenteric vein, superior mesenteric artery, celiac axis and hepatic artery) in predicting the resectability of pancreatic carcinoma[31–34]. In three of these studies[32–34] the proportion of the vessel circumference in contact with the tumor was assessed. All three studies found that when the tumor is not contiguous with the vessel (i.e. when an intervening fat plane is present), vascular invasion is almost never present. When the tumor is contiguous with less than one-quarter of the vessel circumference, it is resectable in the majority of cases, but when the tumor is contiguous with one-quarter to one-half the vessel circumference, it is unresectable in the majority of cases. It is in the group of patients in which the tumor contacts up to one-half the vessel circumference that EUS may be of value to better assess vascular invasion. Otherwise, surgical exploration is needed to determine resectability. Tumors contacting more than one-half the circumference of the vessel are nearly always unresectable. Another study[31] assessed the contour of the tumor at its point of contact with the vessel as a predictor of resectability. Tumors that were inseparable from the vessel but had a convex contour with the vessel wall were resectable in 55% of cases (an additional 34% could be resected but required venous resection). Tumors that were inseparable from the vessel and had a concave contour with the vessel were resectable in only 7% of cases (an additional 40% could be resected but required venous resection). The proportion of vessel circumference involved by tumor is a more reliable predictor of resectability than the tumor contour at its point of contact with the vessel. Another sign of unresectability of adenocarcinoma of the head of the pancreas is a teardrop shape of the superior mesenteric vein (SMV), which represents either direct tumor infiltration of the vein or peritumoral fibrosis adherent to the vessel[35].

Assessment of the peripancreatic veins can also provide information regarding the likelihood of vascular invasion by pancreatic carcinoma. In patients with pancreatic carcinoma, dilatation of the posterior superior pancreaticoduodenal vein or the gastrocolic trunk is a sign of portal or superior mesenteric vein invasion[36–39]. However, a dilated gastrocolic trunk should not be used as an independent sign of surgical unresectability[34].

Our ability to detect and stage pancreatic carcinoma is currently better than it has ever been, and it is very likely that continued technological advances in CT and MR imaging will further improve our diagnostic and staging capabilities. Improvements in pre-operative staging will further minimize the number of patients with unresectable

tumors who undergo needless laparotomy and may help in directing patients to appropriate nonoperative or combined operative and nonoperative forms of therapy, if improved treatment methods become available. Finally, imaging for early detection of pancreatic carcinoma may take on greater importance if genetic screening methods allow identification of individuals who are at high risk for developing this insidious and deadly disease.

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