

# Advancements in Diagnosis and Surgical Management of Pancreatic Head Cancer: A Case Study on Vascular Invasion and Treatment Strategies

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## ABSTRACT

Pancreatic tumors present significant diagnostic and therapeutic challenges due to their complex nature and deep anatomical location. Pancreatic ductal adenocarcinoma (PDAC) is the most common and aggressive subtype, marked by high mortality rates resulting from late-stage diagnosis and frequent vascular invasion. This report presents a case of a 49-year-old male with a pancreatic head mass causing biliary obstruction, emphasizing the role of advanced imaging and multidisciplinary management.

Diagnostic imaging, including multidetector computed tomography (MDCT) and magnetic resonance cholangiopancreatography (MRCP), was critical in determining tumor location and vascular involvement. Venous invasion was identified, which is generally surgically manageable, in contrast to arterial invasion, which complicates surgery. The patient underwent an extended pancreaticoduodenectomy with venous reconstruction, showcasing the potential for surgical intervention in select cases. For those with unresectable tumors, biliary drainage, chemotherapy (e.g., FOLFIRINOX), and palliative care remain important for symptom management and survival extension. This case highlights the importance of precise imaging in evaluating resectability and planning individualized treatments. Despite advances, the prognosis for PDAC remains poor, emphasizing the need for further research into enhanced diagnostic and therapeutic strategies.

**Keywords:** pancreatic tumor, pancreatic oduidenectomy, exocrine tumors, vascular invasion, advanced imaging.

## INTRODUCTION

A pancreatic tumor refers to an abnormal growth of cells in the pancreas.

Pancreatic tumors can be classified as benign serous cystadenoma, mucinous

cystadenoma, intraductal papillary mucinous neoplasms, pancreatic neuroendocrine tumors or malignant pancreatic ductal adenocarcinoma, pancreatic neuroendocrine tumors, acinar cell carcinoma, ampullary

cancer—depending on their behavior and potential to spread.[7]

Pancreatic malignant tumors are cancerous growths that can invade and destroy nearby tissue and spread to other parts of the body.[5]

The most common location for pancreatic tumors, particularly ductal adenocarcinomas, is the head of the pancreas.

Chronic pancreatitis increases the risk of developing pancreatic cancer, often presenting as a mass lesion in the head of the pancreas. A mass lesion in the head of the pancreas can also occur secondary to an inflammatory lesion. Imaging technologies like endoscopic ultrasonography (US) combined with techniques such as fine-needle aspiration, contrast enhancement, elastography, multidetector-row CT, magnetic resonance imaging, and positron emission tomography scanning have been shown to help distinguish between benign (chronic pancreatitis) and malignant (pancreatic cancer) masses.[9]

Biliary obstruction in pancreatic tumors occurs when the tumor interferes with the normal flow of bile from the liver to the small intestine.

-Obstruction Due to Mass Effect: Tumors in the head of the pancreas are the most common cause of biliary obstruction, as this region is anatomically close to the distal common bile duct (hepatopancreatic ampulla).

-Invasion of the Bile Duct: Some malignant pancreatic tumors, particularly pancreatic ductal adenocarcinomas, invade and narrow the wall of the common bile duct.

This leads to consequences such as intrahepatic bile duct dilation, elevated jaundice levels, impaired digestion, and an increased risk of cholangitis.

The optimal treatment—including the decision whether to treat prior to resection—depends on the type of malignancy and the stage of the disease. Preoperative biliary drainage is usually discouraged due to the risk of infectious complications, though some situations may benefit. For patients with advanced disease and palliative goals

only, the choice of stent for endoscopic decompression depends on estimated survival. Plastic stents are favored for survival of <4 months.[6]

## **CASE PRESENTATION**

A 49-year-old male presented with a 3-day history of severe epigastric pain radiating to the

back, jaundice, pruritus, pale stools, and tea-colored urine, accompanied by loose bowel motions but no blood, fever, chills, or weight loss. He also reported chronic back pain for over a month prior to the onset of jaundice. Examination revealed stable vitals and jaundice, with epigastric tenderness. Laboratory tests showed elevated liver function tests, bilirubin, and CA19-9. Imaging (CT and MRCP) confirmed a pancreatic head mass causing biliary obstruction, and ERCP with stent placement was performed for drainage. Following MDT discussion, the patient underwent EUS-guided biopsy on 30/06/2024. The case was managed by the HPB surgical team, with PET scan findings pending. The patient was discharged in stable condition with outpatient follow-up to review biopsy results and finalize management for the pancreatic mass with biliary obstruction, suspected to be malignant.

### **Patient history**

A 49-year-old male, a smoker and professional driver with no history of alcohol use, presented with a 3-day history of severe epigastric pain radiating to the back. The pain was sudden in onset, progressively worsening, and interfered with his ability to work. It was accompanied by yellowish discoloration of the eyes and skin, generalized pruritus, pale stools, tea-colored urine, and loose bowel motions without blood. He denied fever, chills, nausea, vomiting, or significant weight loss. He reported chronic back pain persisting for over a month prior to presentation, which he initially attributed to his occupation and did not seek evaluation.

His past medical history includes a laparoscopic cholecystectomy performed in July 2022 following an episode of biliary pancreatitis, and he was subsequently diagnosed with likely benign ethnic neutropenia, evaluated by hematology during the same period. He has no personal or family history of malignancies or other significant conditions. He smokes regularly and has a sedentary lifestyle due to his occupation, which requires prolonged sitting. He denies alcohol use or exposure to known toxins.

The patient first noticed jaundice three days before presentation, which coincided with the onset of his abdominal pain. He also observed changes in his stool and urine color during this period. Despite worsening symptoms, he continued working until the pain and associated symptoms significantly limited his daily activities, prompting him to seek medical attention.

## **DISCUSSION**

Pancreatic head cancer is among the most aggressive malignancies, ranking as the seventh leading cause of cancer-related mortality globally. Its poor prognosis is largely attributed to the deep anatomical location of the pancreas, its close proximity to major vessels, and the tumor's propensity for early local and distant spread. At the time of diagnosis, only 15–20% of pancreatic cancers are resectable, with the remaining cases comprising approximately 40–50% metastatic and locally advanced pancreatic cancer (LAPC).[1] This study contributes to the growing body of evidence highlighting the critical role of vascular invasion in determining resectability and emphasizes the utility of advanced imaging techniques in assessing vascular involvement.[2]

There are two main types of pancreatic tumors: exocrine tumors and neuroendocrine tumors.

**-Exocrine tumors:** Over 90% of all pancreatic tumors are exocrine tumors. The most common type of pancreatic cancer is pancreatic ductal adenocarcinoma. The majority of adenocarcinomas of the pancreas

arise from the pancreatic duct and can metastasize. Cystic tumors are a special type of exocrine tumor, characterized by the formation of fluid-filled cavities. These are mostly harmless and rarely malignant.

**-Neuroendocrine tumors (NETs):** Less than 10% of pancreatic tumors are neuroendocrine tumors. Islet cell carcinoma is another name for a NET. Neuroendocrine neoplasms (also known as "endocrine" or "islet cell" tumors) account for only 1–5% of pancreatic cancers.[8]

Our case involved an MRI-identified pancreatic head mass that invaded the lower common bile duct, superior mesenteric vein (SMV), and the right colonic mesentery. Despite the vascular involvement, an extended pancreaticoduodenectomy with lymphadenectomy was performed, showcasing the evolving surgical approaches for pancreatic cancer with vascular invasion. Venous resection and reconstruction have become increasingly feasible, allowing for resection in select cases of venous involvement, whereas significant arterial invasion remains a contraindication for surgery due to poor outcomes.[3]

Vascular invasion is a significant consideration in determining the surgical candidacy for pancreatic cancer patients. Studies have reported vascular involvement in 21–64% of patients with pancreatic cancer, with the SMV and portal vein being the most commonly affected due to their anatomical proximity to the pancreas. Tumor contact exceeding 5 mm or circumferential encasement of more than 180 degrees strongly correlates with unresectability. Our findings echo these observations, as SMV involvement was a key determinant in assessing resectability. In our case, the teardrop mesenteric vein sign, a specific indicator of SMV involvement, was observed, further highlighting the importance of detailed imaging in surgical decision-making.[2]

Arterial invasion, particularly involving major vessels like the superior mesenteric artery (SMA), celiac axis, or common hepatic artery (CHA), typically precludes

surgical resection. However, isolated involvement of smaller branches, such as the gastroduodenal artery, does not necessarily contraindicate surgery. This distinction underscores the importance of precise imaging and evaluation to differentiate between arterial and venous involvement. In our study, arterial infiltration was less common than venous involvement, a trend consistent with previous literature attributing this to the thicker and more flexible arterial walls. [1,3]

Advancements in imaging, particularly multidetector computed tomography (MDCT), have revolutionized the diagnosis and staging of pancreatic cancer. MDCT provides detailed information on tumor localization, size, dissemination, and vascular involvement—critical parameters for assessing resectability. Our study demonstrated the high sensitivity (84.2%) and specificity (88.2%) of MDCT in evaluating tumor resectability. Combining axial source data with volumetric rendering (VR) and curved multiplanar reformations (MPR) enhanced the accuracy of vascular invasion assessment. For instance, stretched arterial walls and changes in vessel caliber were more easily appreciated on three-dimensional reconstruction MDCT angiography (MDCTA). [4]

In cases where surgery is not feasible, alternative treatment options such as biliary drainage, surgical biliary bypass, chemotherapy, and local ablative therapies play a vital role. Biliary drainage, often achieved via stenting, is crucial in reducing bilirubin levels to make patients eligible for chemotherapy, such as FOLFIRINOX. This induction chemotherapy regimen, recommended by the National Comprehensive Cancer Network (NCCN), has shown promise in LAPC cases, particularly when vascular invasion precludes surgical intervention. [3] Our findings support the notion that while surgical resection remains the only curative treatment for pancreatic cancer, the survival rates for patients with positive surgical margins are not significantly different from

those undergoing chemoradiotherapy. This underscores the importance of preoperative planning to achieve R0 resection and highlights the limitations of surgery in improving outcomes for LAPC patients. [2]

A major limitation of our study is the reliance on surgical palpation as the gold standard for assessing vascular invasion. Histological confirmation was not possible for unresectable tumors, potentially introducing bias in the evaluation of MDCT accuracy. Future studies should focus on integrating advanced imaging modalities, such as positron emission tomography (PET)-CT or magnetic resonance imaging (MRI), to complement MDCT findings and improve diagnostic accuracy. [4]

Additionally, the development of standardized protocols for assessing vascular invasion and resectability is critical. Incorporating quantitative metrics, such as tumor-vessel contact length and circumferential involvement, can help stratify patients more effectively and guide treatment decisions. [1]

Pancreatic head cancer continues to pose significant diagnostic and therapeutic challenges due to its aggressive nature and complex anatomical relationships. Vascular invasion remains a critical determinant of resectability, with venous involvement being more common and manageable surgically compared to arterial invasion. Advances in imaging techniques, particularly MDCT, have significantly improved the accuracy of staging and resectability assessments. However, for cases deemed unresectable, optimizing non-surgical interventions such as biliary drainage and chemotherapy is crucial in improving patient outcomes. Further research is needed to refine diagnostic criteria and expand therapeutic options for this devastating disease. [2,4]

## **CONCLUSION**

Pancreatic tumors, both benign and malignant, pose significant challenges due to their complexity and the pancreas's deep anatomical location. Benign types, such as serous and mucinous cystadenomas, are

generally harmless, while malignant types, including pancreatic ductal adenocarcinoma (PDAC) and neuroendocrine tumors (NETs), are aggressive and often diagnosed late. PDAC frequently involves critical vascular structures, complicating treatment.

Advanced imaging technologies like MDCT, MRI, and PET-CT are vital for assessing tumor characteristics and resectability. Venous invasion is often surgically manageable, unlike arterial invasion. For non-resectable cases, treatments like biliary drainage, FOLFIRINOX chemotherapy, and palliative care improve outcomes. Innovations in venous resection have expanded surgical options for select patients. Pancreatic head cancer remains one of the deadliest malignancies. Early detection, multidisciplinary care, and refined diagnostic and treatment strategies are essential to improving survival and reducing its global burden.

#### Declaration by Authors

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