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Minimally Invasive Removal of Pancreatic Tumor with Thrombus in Spleen and Liver Vein

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Background	Pancreatic neuroendocrine tumors (pNETs) are rare pancreatic malignancies known to be complicated by venous tumor thrombus (VTT), posing a challenge for surgical resection. Minimally invasive pancreatic surgery has gained widespread adoption; however, laparoscopic management of pNETs involving both portal vein tumor thrombectomy (PVTT) and reconstruction alongside distal pancreatectomy has not been documented in prior literature.
Summary	A 74-year-old male with biopsy-proven grade 2 pNET underwent laparoscopic distal pancreatectomy and splenectomy. Preoperative imaging revealed a tumor thrombus involving the splenic vein extending to the portal vein and inferior mesenteric vein. During surgery, the portal vein was opened at the splenic vein confluence, allowing en bloc resection of the tumor thrombus with the distal pancreas. The portal vein defect was then closed using a 5-0 Prolene running suture. The patient tolerated the procedure well and achieved an uneventful postoperative course, with discharge on POD 3 and complete recovery at outpatient follow-up.
Conclusion	Laparoscopic resection for pNETs with venous tumor thrombus holds promise as a minimally invasive alternative to open surgery. However, further investigation is necessary to definitively assess the associated complications and oncologic outcomes.
Key Words	laparoscopic; hepatobiliary; surgery

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Case Description

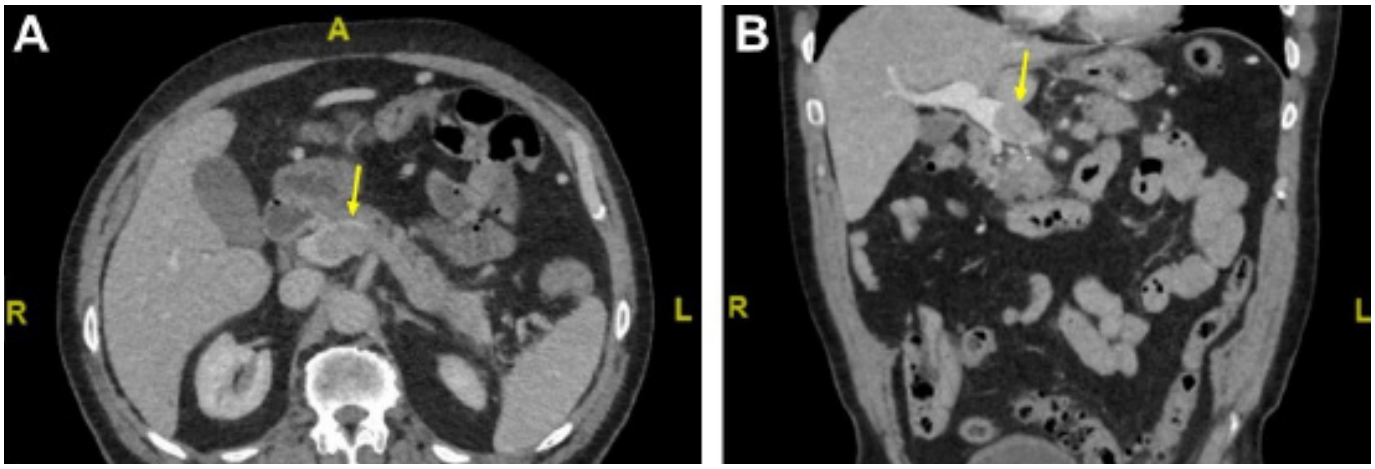
The patient is a 74-year-old man with a past medical history of traumatic brain injury with associated mild dementia, diverticulosis, chronic obstructive pulmonary disease (COPD), dyslipidemia, and hypertension. His surgical history includes a transurethral resection of the prostate (TURP) to address benign prostatic hyperplasia (BPH). Notably, the family history is unremarkable for any known malignancies.

The patient initially presented with an obscure upper gastrointestinal bleed, from which he subsequently recovered, and underwent a diagnostic evaluation. The scan did not reveal the bleeding source but identified a significant mass (6.2 × 3.0 cm) in the tail of the pancreas (Figure 1). Notably, a tumor thrombus was present, completely occluding the splenic vein and extending into the proximal main portal vein. Interestingly, the superior mesenteric vein and arterial supply remained unaffected. Additionally, the CT scan showed no dilation of the biliary or pancreatic ducts, and no signs of distant metastases were observed. These findings raise suspicion for a non-functioning neuroendocrine tumor with associated extensive tumor thrombus.

Endoscopic ultrasound with fine-needle core biopsy revealed findings consistent with a neuroendocrine tumor. Immunohistochemical analysis further supported this diagnosis with positive staining for chromogranin A and synaptophysin. The Ki-67 proliferation index ranged from 3% to 20%, indicating either a low or intermediate-grade tumor. A subsequent Ga-68 DOTA-TATE PET/CT scan showed no signs of distant metastases based on gallium uptake. The patient received two months of preoperative treatment with the long-acting somatostatin analog, lanreotide.

The Neuroendocrine Tumour Multidisciplinary Case Conference reviewed the case. Given the patient's presentation with an angioinvasive, non-functioning, Grade 2 neuroendocrine tumor located in the body and tail of the pancreas, the team opted for surgical resection as the course of treatment.

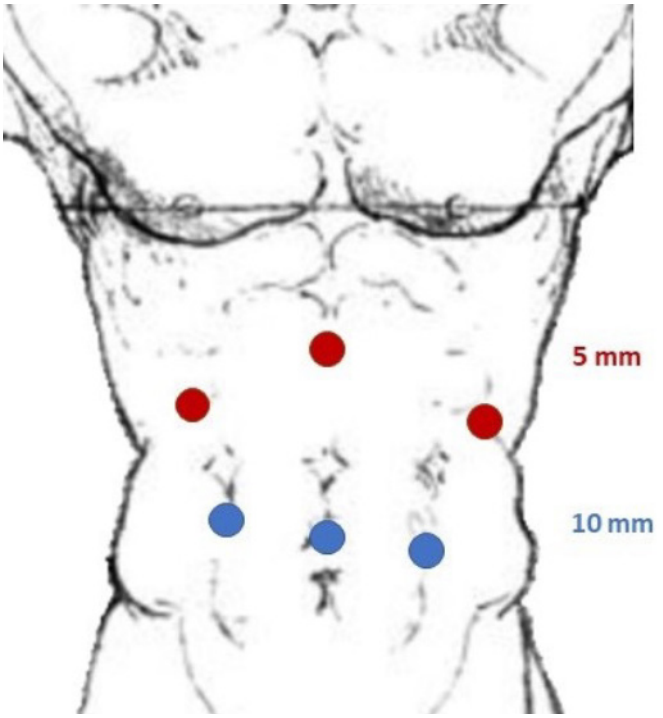
Figure 1. Axial (A) and Coronal (B) Arterial Phase CT Liver. Published with Permission



Scan depicts a filling defect at the splenoportal confluence, consistent with a tumor thrombus (arrows). The filling defect extends proximally to the level of the inferior mesenteric vein (not visualized in this image).

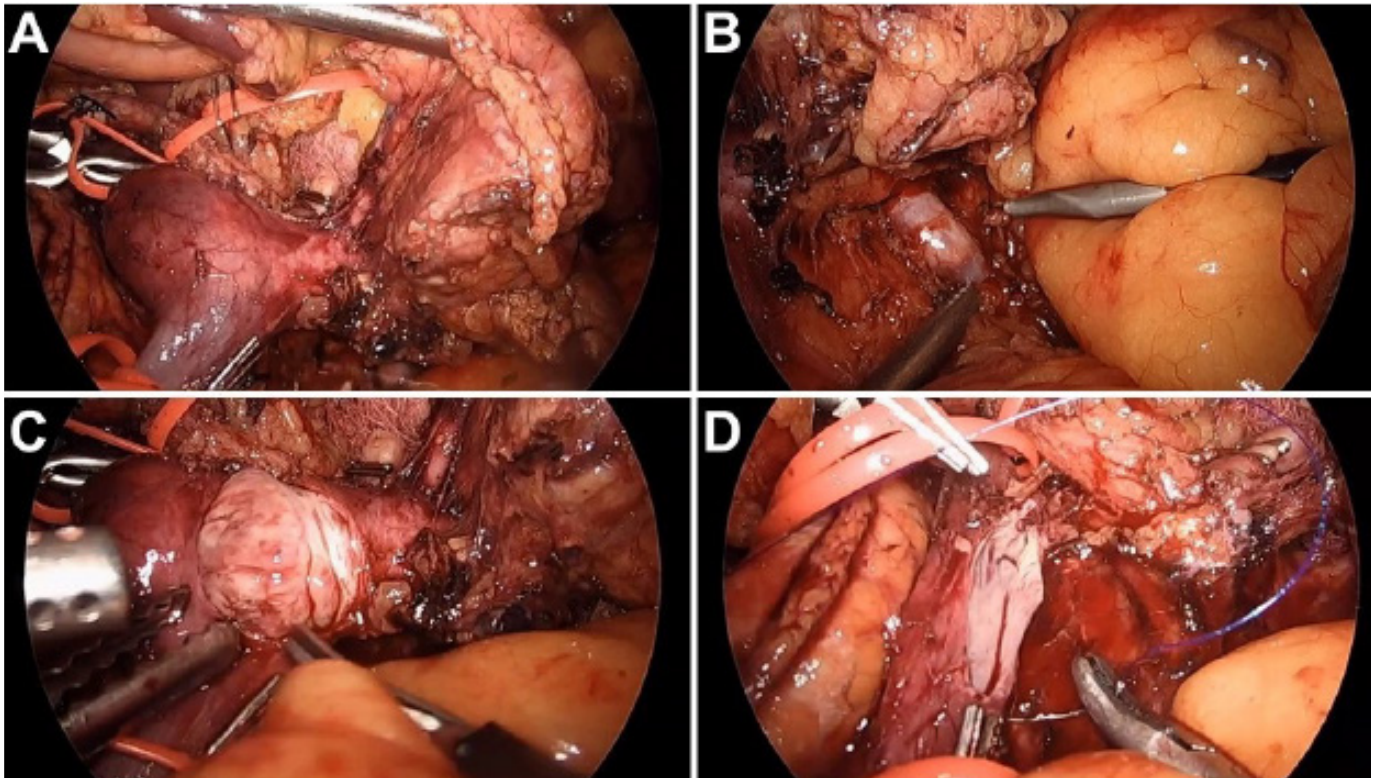
The patient was positioned supine, and five laparoscopic ports were inserted (Figure 2). An additional epigastric incision was made to facilitate the placement of a Nathanson retractor. Dissection through the gastrocolic ligament granted access to the body and tail of the pancreas. Following the identification of major vessels, the gastroduodenal and splenic arteries were clipped and divided to gain superior control of the main portal vein. A vessel loop was used to temporarily occlude the common hepatic artery. The pancreatic neck was transected using a laparoscopic stapler. Intraoperative ultrasound (Figure 3A, 3B) confirmed the presence of a tumor thrombus within the splenic vein, extending into the portal vein and inferior mesenteric vein. The involved segment of the inferior mesenteric vein was ligated proximal to the thrombus. The superior mesenteric vein and main portal vein were then mobilized and controlled using vessel loops. Aesculap laparoscopic bulldog clamps were strategically placed on the distal superior mesenteric vein and main portal vein to achieve complete vascular control. A venotomy was created at the junction of the splenic vein and the porto-mesenteric confluence. The tumor thrombus was extracted from the vein (Figure 3C) and preserved with the resected pancreatic specimen for en-bloc removal.

Figure 2. Illustration of Port Placement.



The umbilical port was extended for specimen extraction.

Figure 3. Laparoscopic Dissection and Resection of Portal Vein Tumor Thrombus. Published with Permission



Tumor thrombus located A) at the splenoportal confluence and B) within the inferior mesenteric vein. C) Intraoperative view during venotomy at the junction of the splenic vein, facilitating the extraction of the tumor thrombus. D) Laparoscopic reconstruction of the portal vein following tumor thrombus removal.

The initial examination revealed clear margins with no signs of remaining diseased tissue. Following this, the severed vein (venotomy) was repaired using a continuous 5-0 Prolene suture (Figure 3D). Hemostasis was confirmed after removing the clamps from the proximal and distal ends of the vessel. Additionally, laparoscopic Doppler ultrasound was employed to verify unobstructed blood flow through the repaired vein. Subsequently, the pancreas was fully mobilized from its remaining posterior connections, and the splenic attachments were also taken down. Finally, both organs were individually placed in separate specimen bags. Blood loss was estimated at approximately 400 mL.

Following an unremarkable postoperative course, the patient was discharged home in stable condition on day 3. Final pathology confirmed a poorly differentiated large cell neuroendocrine carcinoma, measuring 4.6 cm, with tumor thrombus, classified as ypT3ypN1. Microscopic examination showed involvement of the proximal splenic vein margin, while all other margins remained free of tumor. Two out of thirteen lymph nodes displayed cancerous cells. Immunohistochemistry revealed diffuse positivity for synaptophysin and chromogranin, indicating neuroendocrine differentiation. The Ki-67 proliferation index was 32.6%, and the mitotic count reached 33 per 2 mm^2, signifying a high proliferative rate.

A one-month postoperative follow-up revealed successful recovery with no complications. All incisions related to the surgery and the extraction sites displayed complete healing (Figure 2). Based on the final pathology, the patient underwent a joint consultation with medical and radiation oncology specialists to determine the need for potential adjuvant therapy.

Discussion

Pancreatic neuroendocrine tumors (pNETs) constitute a distinct category of pancreatic malignancies originating from the endocrine tissue of the pancreas. Comprising 2 to 5% of all pancreatic cancers,[1,2] pNETS often exhibit indolent behavior with low malignant potential. Consequently, many cases are discovered incidentally.[3,4] A key feature in pNET classification is the distinction between functional and non-functional tumors based on the clinical presence of hypersecretion syndromes. Notably, approximately 90% of pNETs fall under the non-functional category, contributing to morbidity and mortality primarily through local tissue invasion rather than excessive hormone secretion.[2,4]

Management of pNETs has transitioned from historical active surveillance to a more aggressive approach in recent decades. This shift is supported by the potential benefits of surgery, locoregional therapy, systemic therapy, and comprehensive complication control. While this approach is thought to be superior, evidence-based trials are still lacking.[4–6] Current ENETS guidelines recommend surgical resection for non-functioning tumors exceeding 2 cm. For smaller tumors (<2 cm), either surgery or active surveillance may be considered.[7] Emerging evidence suggests that neoadjuvant therapy with capecitabine/temozolomide might be effective in reducing tumor burden before surgery in cases of locally advanced disease.[8]

While recent evidence has called into question the benefit and safety of the laparoscopic approach for pancreatoduodenectomy,[9,10] laparoscopic distal pancreatectomy has emerged as a safe and potentially advantageous surgical approach with improved or comparable patient outcomes. Compared to open surgery, laparoscopic pancreatic surgery offers advantages in terms of reduced blood loss, faster return to oral intake, and shorter hospital stays. Notably, there is no significant difference in operative morbidity or oncologic outcomes between the two approaches. [11–13] However, long-term survival data specifically comparing laparoscopic and open surgery for malignant cases remains limited, requiring further investigation through randomized controlled trials.[14]

Pancreatic neuroendocrine tumors (pNETs) can exhibit a rare growth pattern involving venous invasion, leading to tumor thrombus formation. The literature lacks a comprehensive understanding of its incidence. While aggressive surgical intervention for locally advanced pNETs demonstrates excellent disease-free survival rates,[15] the presence of tumor thrombus significantly worsens the prognosis across various tumor types.[16]

Surgical management for such cases necessitates either thrombectomy or a more extensive procedure involving venous resection and subsequent reconstruction. Importantly, even with a grossly uninvolved surgical margin during thrombus resection, microscopic involvement remains a possibility.

Traditionally, open surgery has been the preferred approach for managing pNETs with portal vein thrombus. A literature review encompassing case reports from 1990 to 2014 revealed eight documented cases of surgically managed pNETs with portal vein thrombus,[17] of which employed the open approach.

Recent advancements have witnessed successful reports of laparoscopic techniques for complex venous resections in pancreatic adenocarcinoma.[18–20] This case report presents the first documented instance of a laparoscopic resection performed on a pNET harboring a portal vein tumor thrombus.

Conclusion

This report details the first documented instance of a laparoscopic distal pancreatectomy with concomitant portal vein thrombectomy for a neuroendocrine tumor harboring venous tumor thrombus. The findings suggest the potential feasibility of a laparoscopic approach for such cases involving the portal venous system. However, further comprehensive evaluation is necessary to definitively establish the safety and oncological efficacy of this technique.

Lessons Learned

Laparoscopic surgery emerges as a viable option for managing pNETs complicated by venous thrombus, even when portal vein resection becomes necessary. However, it is crucial to note that intraoperative frozen section analysis should be strongly considered for pNETs exhibiting macrovascular invasion. This technique allows for the assessment of microscopic margin status, ensuring complete tumor removal and potentially reducing the risk of positive margins and recurrence.

References

1. Rawla P, Sunkara T, Gaduputi V. Epidemiology of Pancreatic Cancer: Global Trends, Etiology and Risk Factors. *World J Oncol*. 2019;10(1):10-27. doi:10.14740/wjon1166
2. Halfdanarson TR, Rabe KG, Rubin J, Petersen GM. Pancreatic neuroendocrine tumors (PNETs): incidence, prognosis and recent trend toward improved survival. *Ann Oncol*. 2008;19(10):1727-1733. doi:10.1093/annonc/mdn351
3. Genc CG, Klümpen HJ, van Oijen MGH, van Eijck CHJ, Nieveen van Dijkum EJM. A Nationwide Population-Based Study on the Survival of Patients with Pancreatic Neuroendocrine Tumors in The Netherlands. *World J Surg*. 2018;42(2):490-497. doi:10.1007/s00268-017-4278-y
4. Ro C, Chai W, Yu VE, Yu R. Pancreatic neuroendocrine tumors: biology, diagnosis,and treatment. *Chin J Cancer*. 2013;32(6):312-324. doi:10.5732/cjc.012.10295
5. Yu R. Radiotherapy: Radioactive somatostatin analog therapy against carcinoids. *Nat Rev Endocrinol*. 2010;6(8):428-430. doi:10.1038/nrendo.2010.94
6. Kvols LK. Revisiting C.G. Moertel's land of small tumors [published correction appears in J Clin Oncol. 2009 Feb 20;27(6):1002]. *J Clin Oncol*. 2008;26(31):5005-5007. doi:10.1200/JCO.2008.19.2161
7. Partelli S, Bartsch DK, Capdevila J, et al. ENETS Consensus Guidelines for Standard of Care in Neuroendocrine Tumours: Surgery for Small Intestinal and Pancreatic Neuroendocrine Tumours. *Neuroendocrinology*. 2017;105(3):255-265. doi:10.1159/000464292
8. Squires MH, Worth PJ, Konda B, et al. Neoadjuvant Capecitabine/Temozolomide for Locally Advanced or Metastatic Pancreatic Neuroendocrine Tumors. *Pancreas*. 2020;49(3):355-360. doi:10.1097/MPA.0000000000001500
9. van Hilst J, de Rooij T, Bosscha K, et al. Laparoscopic versus open pancreatoduodenectomy for pancreatic or periampullary tumours (LEOPARD-2): a multicentre, patient-blinded, randomised controlled phase 2/3 trial. *Lancet Gastroenterol Hepatol*. 2019;4(3):199-207. doi:10.1016/S2468-1253(19)30004-4
10. Wang M, Li D, Chen R, et al. Laparoscopic versus open pancreatoduodenectomy for pancreatic or periampullary tumours: a multicentre, open-label, randomised controlled trial. *Lancet Gastroenterol Hepatol*. 2021;6(6):438-447. doi:10.1016/S2468-1253(21)00054-6
11. Mehrabi A, Hafezi M, Arvin J, et al. A systematic review and meta-analysis of laparoscopic versus open distal pancreatectomy for benign and malignant lesions of the pancreas: it's time to randomize. *Surgery*. 2015;157(1):45-55. doi:10.1016/j.surg.2014.06.081
12. Xourafas D, Tavakkoli A, Clancy TE, Ashley SW. Distal pancreatic resection for neuroendocrine tumors: is laparoscopic really better than open?. *J Gastrointest Surg*. 2015;19(5):831-840. doi:10.1007/s11605-015-2788-1
13. de Rooij T, van Hilst J, van Santvoort H, et al. Minimally Invasive Versus Open Distal Pancreatectomy (LEOPARD): A Multicenter Patient-blinded Randomized Controlled Trial. *Ann Surg*. 2019;269(1):2-9. doi:10.1097/SLA.0000000000002979
14. Riviere D, Gurusamy KS, Kooby DA, et al. Laparoscopic versus open distal pancreatectomy for pancreatic cancer. *Cochrane Database Syst Rev*. 2016;4(4):CD011391. Published 2016 Apr 4. doi:10.1002/14651858.CD011391.pub2
15. Titan AL, Norton JA, Fisher AT, et al. Evaluation of Outcomes Following Surgery for Locally Advanced Pancreatic Neuroendocrine Tumors. *JAMA Netw Open*. 2020;3(11):e2024318. Published 2020 Nov 2. doi:10.1001/jamanetworkopen.2020.24318
16. Quencer KB, Friedman T, Sheth R, Oklu R. Tumor thrombus: incidence, imaging, prognosis and treatment. *Cardiovasc Diagn Ther*. 2017;7(Suppl 3):S165-S177. doi:10.21037/cdt.2017.09.16

17. Prakash L, Lee JE, Yao J, et al. Role and Operative Technique of Portal Venous Tumor Thrombectomy in Patients with Pancreatic Neuroendocrine Tumors. *J Gastrointest Surg*. 2015;19(11):2011-2018. doi:10.1007/s11605-015-2914-0
18. Voskanyan SE, Shabalin MV, Artemiyev AI, et al. Polnost'yu laparoskopicheskaya dp-car s rezektsiei vorotnoi veny (klinicheskoe nablyudenie) [Pure laparoscopic DP-CAR procedure with portal vein resection]. *Khirurgiia (Mosk)*. 2019;(9):93-98. doi:10.17116/hirurgia201909193
19. Wang X, Cai Y, Zhao W, et al. Laparoscopic pancreatoduodenectomy combined with portal-superior mesenteric vein resection and reconstruction with interposition graft: Case series. *Medicine (Baltimore)*. 2019;98(3):e14204. doi:10.1097/MD.0000000000014204
20. Kendrick ML, Sclabas GM. Major venous resection during total laparoscopic pancreaticoduodenectomy. *HPB (Oxford)*. 2011;13(7):454-458. doi:10.1111/j.1477-2574.2011.00323.x