

# Synchronous Hemihepatectomy With Pancreatectomy Through Application of Associated Liver Partition and Portal Vein Ligation for a Metastatic Gastrinoma

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Pancreatic neuroendocrine tumors with metastases to the liver present a notoriously difficult surgical problem. Unlike other malignancies, metastatic disease does not always preclude surgical resection and systemic therapy options are limited. Associate liver partition and portal vein ligation for staged hemihepatectomy (ALPPS) is a complex, uncommonly performed procedure that may allow for complete resection of primary and metastatic tumors without compromising liver function. We describe a case in which a patient with bilobar hepatic metastases from a pancreatic neuroendocrine gastrinoma tumor was successfully treated with an ALPPS procedure with synchronous pancreatectomy. The technical aspects of the operation, as well as the current state of literature regarding treatment of these tumors and outcomes in this procedure are discussed.

The patient is a 61-year-old female with no significant past medical history who initially presented to her primary care physician with dyspepsia and 30-lb weight loss. She was ultimately diagnosed with Zollinger-Ellison syndrome based on a gastrin level of 506 pg/mL and esophagogastroduodenoscopy revealing severe, diffuse, prepyloric ulceration. Magnetic resonance imaging revealed 2 dominant right hepatic lesions measuring 7.1 × 7.9 × 8.2 cm in segment 6/7 and 5.3 × 7.8 × 7.1 cm in segment 5/8. Additional lesions were identified in the left hepatic lobe in segment 4 measuring 5.7 × 5.8 × 3.9 cm, in segment 3 measuring 6.0 × 5.4 × 3.0 cm, and a small focus of disease in segment 1 (Figure 1A). Last, a heterogeneous postcontrast enhancing lesion measuring 7.4 × 3.2 cm axially was noted in the tail of the pancreas with enhancement and intralesional calcifications (Figure 1B). In summary, her disease burden included her distal pancreas and liver segments 1, 3, 4, 5, 6, 7, and 8.

Biopsy taken of 1 of the hepatic masses confirmed metastatic neuroendocrine tumor with positive staining with chromogranin and synaptophysin. The duodenum was uninvolved and additional imaging was negative for distant metastasis. The patient was subsequently placed

on 2 one-month cycles of Capecitabine and Temozolomide with plan for surgery to occur 4 months following the onset of her diagnostic workup. She had a partial response to chemotherapy as repeat computed tomography (CT) revealed the patient's largest right hepatic lobe lesion in segment 6/7 measured 3.6 × 4.4 × 5.5 cm; there was interval decrease in size of the mass in segment 4 which measured 3.2 × 4.7 × 3.1 cm. The mass in the tail of the pancreas measured 3.2 × 7.5 × 7.9 cm, down from 3.7 × 7.7 × 9.9 cm 2 months prior.

Based on tumor locations, she would require right trisegmentectomy, partial left lateral hepatectomy, and distal pancreatectomy for surgical cure. Preoperative CT revealed that her total liver volume was 1892 cm<sup>3</sup> with left lateral segment volume of 643 mL (33.9% functional liver remnant). Despite an adequate functional liver remnant, the risk of simultaneous right trisegmentectomy and pancreatectomy was prohibitive, particularly in the event of a post hepatectomy and/or pancreatectomy complication. Thereby an ALPPS approach was elected for this patient. The two-stage approach would allow assessment of adequate hypertrophy of the left lateral segment and evaluation for pancreatic leak prior to completion of right trisegmentectomy.

Surgical access was obtained with a Mercedes incision. First, the pancreas was exposed through the lesser sac and fully mobilized. The splenic artery and vein were ligated

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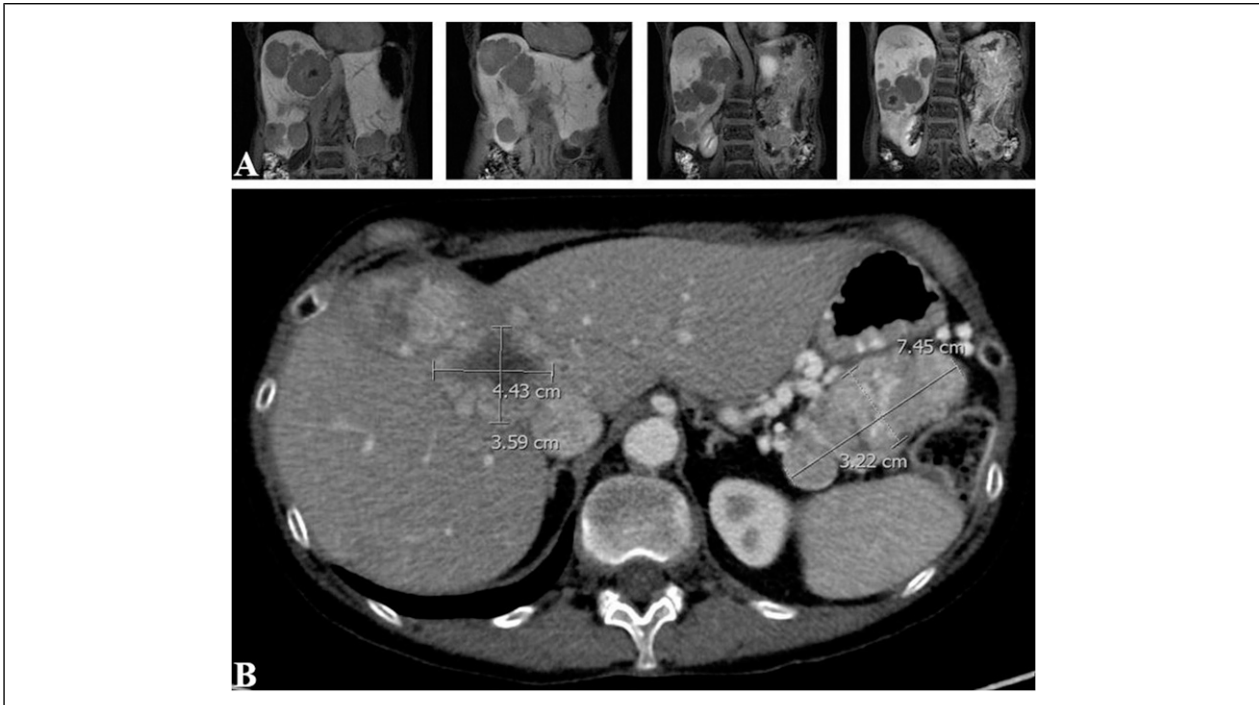
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**Figure 1.** Preoperative imaging. (A). Preoperative coronal magnetic resonance imaging from anterior to posterior at time of initial diagnosis, demonstrating the significant disease burden involving segments 1, 3, 4, 5, 6, 7, and 8. (B). Preoperative axial computed tomography image of disease following neoadjuvant chemotherapy showing large pancreatic mass as well as the segment 4 and 8 masses.

and the body of the pancreas divided with a stapler ensuring a grossly clear tumor margin; frozen section of the margin was negative. The 2 metastatic lesions on segment 3 of the liver were identified and resected. The gallbladder was removed and hilum approached. The right portal vein was isolated and suture ligated, preserving the portal confluence. The right hepatic artery was identified and preserved and loosely encircled with a silk suture that was marked with clips for division at the second-stage surgery. The right liver was mobilized and short hepatic veins divided. The right hepatic vein was identified, circumferentially dissected and preserved, and was also loosely encircled with a silk suture that was marked with clips for division at the second-stage surgery.

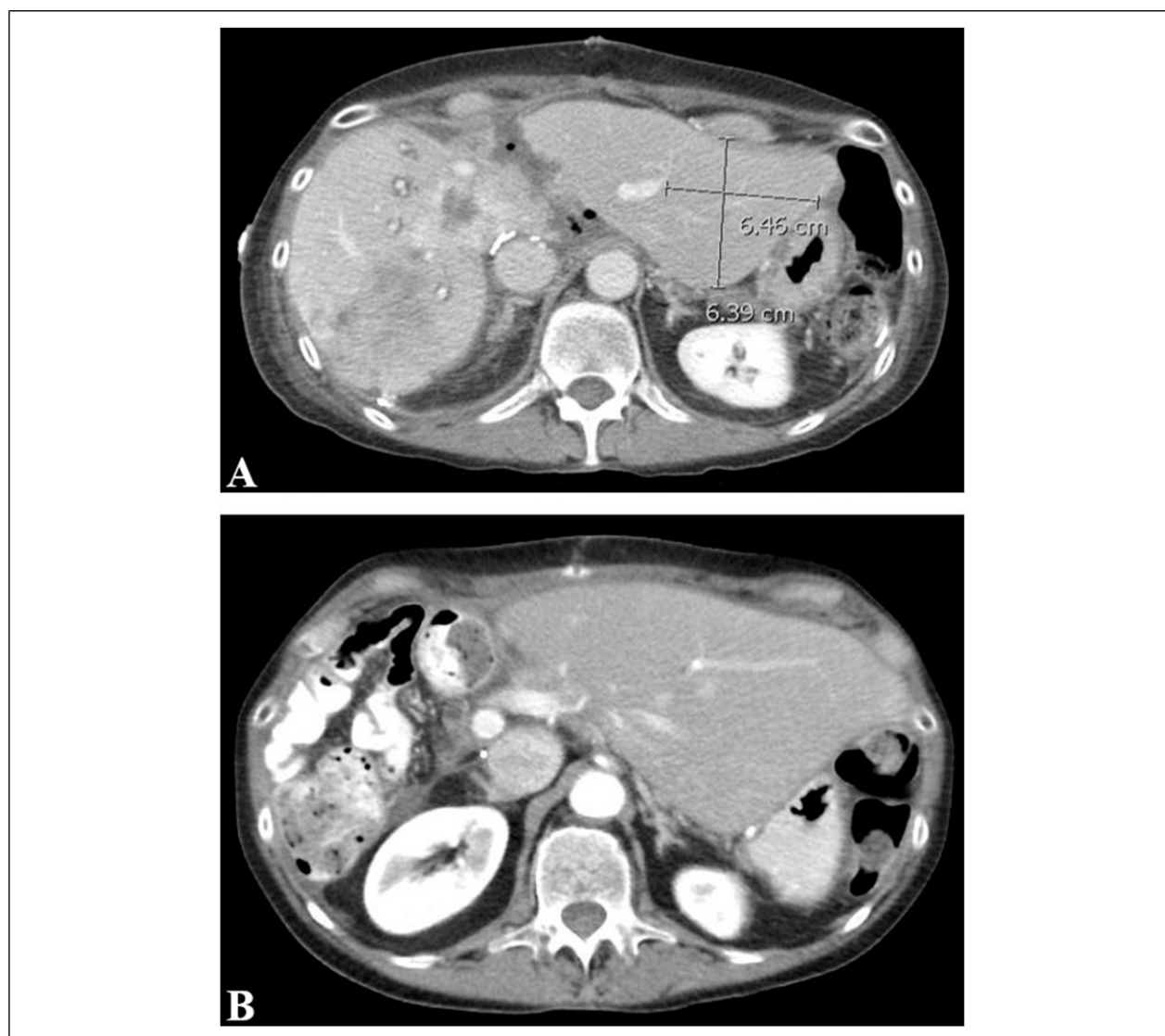
The liver was marked 1 cm to the right of the falciform ligament ensuring a negative margin on all liver masses. The liver parenchyma was then partitioned using electrocautery and Sonopet™ ultrasonic aspirator (Stryker, Kalamazoo, Michigan). The partition was carried to the porta where the hepatic artery and common hepatic duct were clearly identified and left intact. The hepatic veins were also left intact. Hemostasis was achieved, 2 drains were left in the upper left and right quadrants and the incisions closed.

Postoperatively she recovered well and there was no clinical evidence of pancreatic leak. In addition, her left drain was sampled for amylase and was normal relative to

her serum amylase. Repeat CT abdomen was performed on postoperative day 6 to assess for liver hypertrophy (Figure 2A). The left lobe hypertrophied from 643 cm<sup>3</sup> preoperatively to 717 cm<sup>3</sup> on postoperative day 6 following stage 1 (11.5% hypertrophy, which would leave a 37.9% functional liver remnant).

On postoperative day 7, the patient returned to the operating room. The patient's prior chevron and midline sutures were reopened and access to the abdomen was obtained. After brief exploration, the liver was found to be loosely adherent to the anterior abdominal wall and was easily taken down. The previous silk ties that were loosely placed around the right hepatic artery, right hepatic duct, and right hepatic vein were identified. The right hepatic artery and right hepatic duct were suture ligated and divided. The right hepatic vein was divided with a vascular stapler. Additional disease was visualized in the caudate lobe and this was removed en bloc with the right trisegmentectomy specimen. The specimen, once removed, contained segments 1, 4, 5, 6, 7, and 8 of the liver. The abdomen was irrigated, hemostasis ensured, and incisions closed.

Postoperatively, the patient recovered well and was discharged home on postoperative day 20 from the index procedure. Clavien-Dindo classification of her postoperative complication was limited to 1 class 2 for a postoperative urinary tract infection for which she was



**Figure 2.** Postoperative imaging. (A). Postoperative day 6 computed tomography (CT) demonstrating right liver disease burden and hypertrophy of the left lateral segment. (B). Three-month surveillance CT demonstrating left lateral segment robust hypertrophy and no evidence of disease recurrence.

treated with antibiotics and recovered well. Postoperative liver function testing remained normal. Reimaging on postoperative day 43 from her completion surgery revealed a remnant liver volume of 1016 cm<sup>3</sup> (Figure 2B).

On pathologic review, the patient was staged as ypT3N1M1 with a G1 or low-grade primary pancreatic neuroendocrine tumor. All margins were R0 and the specimen staining revealed immunopositivity to chromogranin, synaptophysin, and CD56 in both the primary and metastatic lesions consistent with preoperative biopsies. At 36 months postoperatively, the patient has recovered well and currently has no evidence of tumor recurrence on imaging or biochemical studies. She underwent 9 cycles of Temodar with Capecitabine for adjuvant chemotherapy followed by a transition to Lanreotide.

Compared to more aggressive pancreatic tumors, surgical resection of pancreatic neuroendocrine tumors has been associated with relative oncologic success. In addition, current evidence suggests that local, regional, and metastatic resection of pancreatic neuroendocrine tumors is associated with improved survival across all disease stages.<sup>1,2</sup> With that said, surgical approaches, particularly the synchronous hemihepatectomy with pancreatectomy, have proven to be challenging. Recent American College of Surgeons National Surgical Quality Improvement Program data confirm the high morbidity and mortality of synchronous hemihepatectomy with pancreatectomy, with reported morbidity rates of 87.5% and 8.3% 30-day mortality.<sup>3</sup>

Associate liver partition and portal vein ligation for staged hemihepatectomy, originally validated by Schnitzbauer et al in 2012, has been tested in multiple settings to induce rapid hypertrophy of the non-diseased lobe. The hypertrophy of the future liver remnant (FLR) with the use of ALPPS has been shown to be greater and faster than that reported with portal vein embolization or portal vein ligation alone. While the physiology of these postoperative changes is still being studied, the hypothesis remains that in situ splitting of the liver in conjunction with ligation of the portal vein prevents neovascularization and supports more rapid and pronounced growth of the FLR.<sup>4</sup>

We present a unique case in which the ALPPS procedure was applied to the primary excision of a pancreatic neuroendocrine gastrinoma tumor with bilobar hepatic metastasis in an attempt to avoid the known complications of synchronous hemihepatectomy with pancreatectomy and preserve the patient's hepatic function while completely excising the primary tumor and its metastases. We demonstrate that the ALPPS procedure is a feasible technique in the treatment of metastatic pancreatic neuroendocrine tumors and an alternative to single-staged synchronous hemihepatectomy and pancreatectomy in the appropriate patient.

### Declaration of Conflicting Interests

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