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Case Report

Staged Celiac Artery Resection with Pancreatosplenectomy (SCARPS) - A Novel Approach to Pancreatic Cancer Encasing Celiac Axis Trunk Robotically

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Abstract

To avoid hepatobiliary and gastric ischaemia related directly to Appleby and Kondo's procedures, a novel SCARPS procedure (**S**taged **C**eliac **A**rtery **R**esection with **P**ancreato**S**plenectomy) for resection of pancreatic cancer involving celiac axis trunk is described here. A 67-year-old female with biopsy proven Pancreatic Ductal Adenocarcinoma (PDAC) encasing celiac and common hepatic artery underwent two stage robotic operation with Da Vinci Xi following 12 cycles of neoadjuvant FOLFIRINOX and 45 Gy chemoradiation. Stage 1 consisted of diagnostic laparoscopy and ligation of Common Hepatic Artery (CHA) after a trial of vascular clamping with real time assessment of hepatic artery flow using laparoscopic / robotic intraoperative doppler ultrasound and stage 2 resection of celiac axis trunk and CHA with pancreatosplenectomy 2 weeks after stage 1 following a repeat CT abdomen/pancreas. Both procedures were performed robotically. Hepatic Artery Resistive Index (HARI) increased to 0.8 after ligation of CHA with preserved forward flows. The operative time was 80 min and 240 min for stage 1 and 2 respectively with minimal blood loss without perioperative blood transfusion. SCARPS offers a safe ligation of CHA following an intraoperative assessment of disease status and a real-time hepatic haemodynamic study prior to major pancreatosplenectomy with celiac axis trunk resection. Furthermore, it is described fervently as a minimally invasive approach to resection of pancreatic cancer with vascular involvement to benefit patients directly for quick recovery.

Keywords: Kondo's procedure; Locally advanced pancreatic cancer; Modified Appleby procedure; RAMPS (Radical Antegrade Modular Pancreatic Splenectomy); Robotic distal pancreatectomy splenectomy

Introduction

Two surgical procedures, modified Appleby and Kondo's operation, have been described for resection of locally advanced pancreatic cancer encasing celiac axis [1,2]. Although the former was described originally by Appleby for resection of locally advanced gastric cancer, it has gained popularity for pancreatic resection after its modification. To prevent the ischaemic risks related directly to the ligation of common hepatic artery with Appleby's procedure, Kondo described radiological embolization of common hepatic artery 2 weeks prior to distal pancreatectomy and splenectomy with celiac artery resection to allow sufficient time to improve the blood supply to hepatobiliary system through gastroduodenal artery via collaterals. However, the major drawbacks of this procedure are a lack of intraoperative real-time assessment of disease and hepatic haemodynamics with an irreversible consequence after embolization of common hepatic artery. A novel surgical approach coined as SCARPS (Staged Celiac Artery Resection with Pancreato Splenectomy) is described here to avoid ischaemic problems related to both Appleby and Kondo's procedures and to benefit patients directly with minimally invasive approach.

Case Report

A 67-year-old female presented with a 3-month history of back ache. She is a known case of hypothyroidism, hyperlipidaemia and ischaemic heart disease with possible Takotsubo syndrome for which she was on ramipril, bisoprolol, thyroxine, atorvastatin and aspirin. She is a non-smoker and consumes alcohol occasionally. There is no family history of pancreatic cancer. Although her CA19-9 level was 12.2, her abdominal CT scan showed a 34 x 22 mm lesion in the body of pancreas encasing the celiac axis without regional or distant metastasis (Figure 1 a&b). There were also 2 small indeterminate lesions in her lungs on staging chest CT. The FDG PET/CT scan showed a mild uptake in the pancreatic tumour only (SUV 5) without any regional or distant pet avid lesion elsewhere (Figure 1a). The EUS biopsy confirmed the diagnosis of pancreatic adenocarcinoma (PDAC, Figure 2). Genetic analysis showed no DYPD mutations and molecular profiling revealed MMRp and HER2 negative and PDL1 CPS 5.

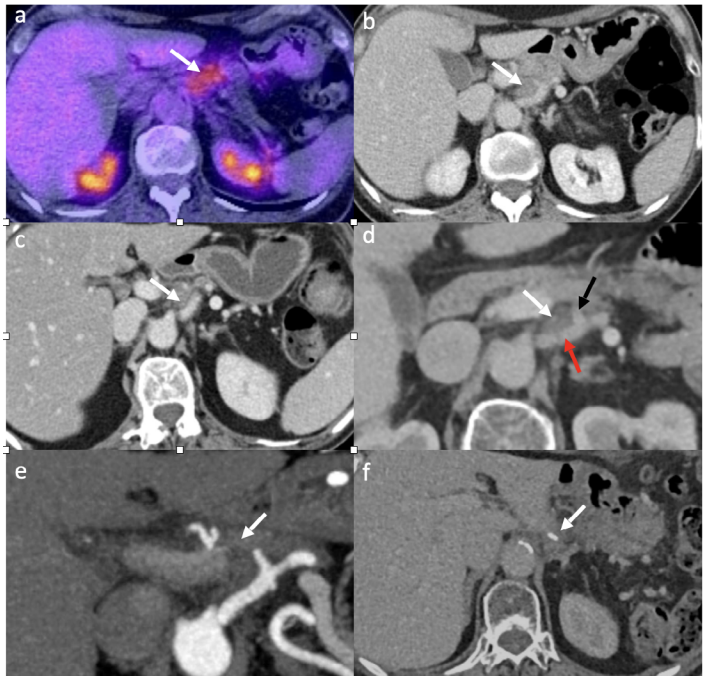

Figure 1: Baseline 18F-FDG PET/CT (a, arrow) demonstrates FDG avid-mass in the pancreatic neck. Baseline contrast-enhanced axial CT (CECT) in the portal-venous phase (b) demonstrating a 3.4cm soft tissue mass (arrow) and upstream pancreatic duct dilatation (not shown) consistent with pancreatic ductal adenocarcinoma. Tumour staged as T4 by virtue of near complete encasement of the celiac trunk and encasement of the common hepatic artery. Following neo-adjuvant therapy (c, d) the tumour has shrunk but tissue (white arrow) remains in contact with the coeliac trunk (red arrow, d) and common hepatic artery origin (black arrow, d). Axial CECT maximum intensity projection (MIP) in the arterial phase (e) following intra-operative hepatic artery ligation demonstrates occlusion of the hepatic artery (white arrow). Post-operative CECT (f) showing staple at site of celiac artery resection (arrow).

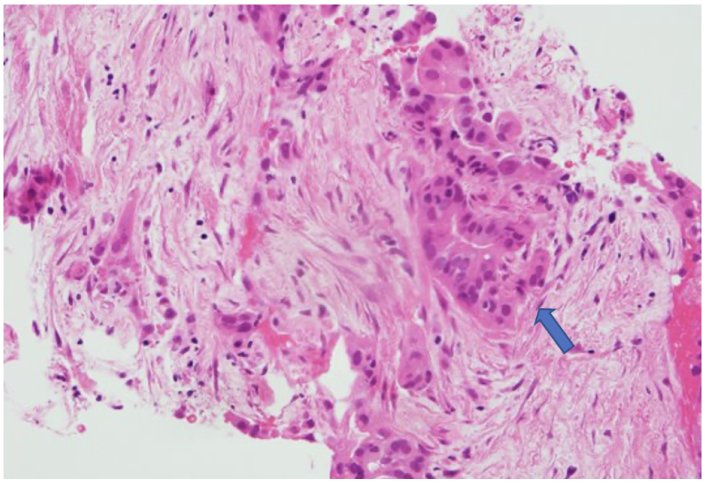

Figure 2: Histology of pancreatic biopsy showing infiltration of malignant glands/ductules in dense stroma.

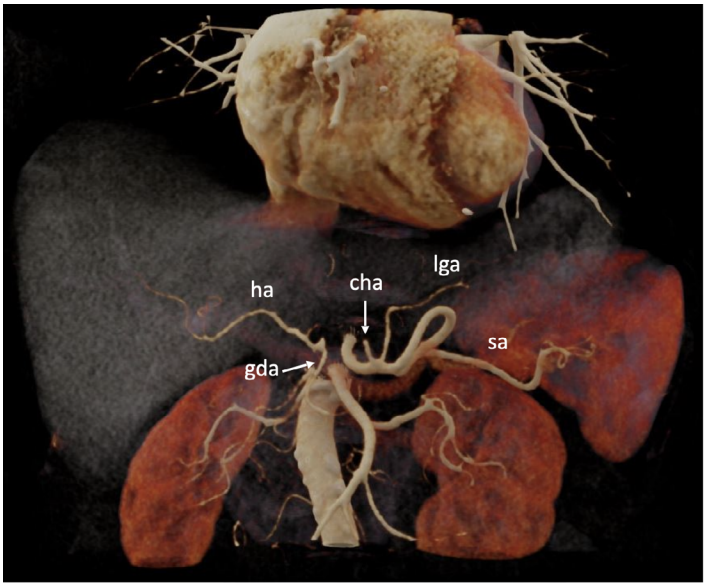

Figure 3: Cinematic Volume Rendering Technique (VRT) of arterial-phase CT data (as seen in Figure 1e) post intra-operative hepatic artery ligation. Proximal abdominal aorta has been digitally removed to highlight the arterial anatomy. cha – common hepatic artery, lga – left gastric artery, sa- splenic artery, gda – gastroduodenal artery, ha – hepatic artery.

Following our central hepatobiliary and pancreatic Multidisciplinary Meeting (MDT), she was started on 2 weekly FOLFIRINOX (fluorouracil, Irinotecan, oxaliplatin, leucovorin) for 6 cycles initially with a view to assessing the response for consideration of resection. She tolerated the chemotherapy well except having grade 1 diarrhoea, nausea and sore throat which were managed medically with aprepitant and filgrastim. The interval CT chest and abdomen scan after 6 cycles showed a reduction in the size of the pancreatic cancer to 25 x 16mm from 34 x 22 mm. Because of a favourable response to systemic chemotherapy and a good tolerance to it, she was planned for further 6 cycles of FOLFIRINOX followed by chemoradiation to increase the oncological safety of surgical margin. She was given 45 Gy radiation in 15 fractions along with capecitabine. However, she required a dose reduction after 8 cycles of chemotherapy due to fatigue and low appetite.

Two indeterminate lesions in her lungs were considered inflammatory on review of her interval scans. However, as she was planned for major resection of her pancreatic cancer with celiac axis trunk, she underwent extensive preoperative assessment for her chest and heart. Diagnostic bronchoscopy with lavage was performed for cytology and microbiology including tuberculosis and fungal cultures. The results showed elevated aspergillus galactomannan and mycobacterium abscess without cancer. The infection would normally warrant 18-24 months of combination antibiotics. As she didn't have any respiratory symptoms, it was decided for surveillance only after taking into consideration of pros and cons of long course antibiotics. The echocardiogram showed mild tricuspid regurgitation with ejection fraction of 63%. Cardiac opinion was obtained for Toksubo syndrome with the recommendation for preoperative rehydration to avoid the risk of hypotension at induction, avoidance of perioperative adrenaline, continuation of bisoprolol and omittance of ramipril if blood pressure were low. Patient was given vaccines for post splenectomy status as per the guidelines with pneumovax II, meningococcal ACWY, meningococcal B and influenza.

After completion of her neoadjuvant chemotherapy and chemoradiotherapy, restaging CT chest and abdomen and PET/CT scans were performed which confirmed a favourable response to treatment (Figure 1c&d). She was offered surgical resection after a detailed discussion of surgical vs non-surgical treatment options with her. Given the complexity of operation involved, she underwent a diagnostic laparoscopy. At laparoscopy, there was no disease outside the primary tumour, it was decided to proceed directly to surgical ligation of CHA robotically with intrahepatic haemodynamic study rather than delay her operation to wait for embolization of CHA and Kondo's operation, the preferred option in our unit for celiac axis resection with distal pancreatectomy. Following ligation of the CHA, she had a repeat CT abdomen and pancreas 10 days post stage 1 operation (Figure 1e and Figure 3) before she underwent robotic Radical Antegrade Modular Pancreatic Splenectomy (RAMPS) with en bloc resection of celiac axis trunk and CHA 2 weeks later.

Stage 1: Diagnostic laparoscopy and common hepatic artery ligation after a trial of clamping to assess hepatic arterial flow using intraoperative laparoscopic/robotic Doppler ultrasound.

Port placements were made as per standard for robotic pancreatic operation in our unit with patient in reserve Trendelenburg position (Figure 4). A 12mm sub umbilical Hasan assistant port was created first for induction of pneumoperitoneum and diagnostic laparoscopy. Following a negative laparoscopy, four 8 mm robotic ports were inserted 4 cm above the level of the umbilical port incision as shown in Figure 4 with the standard docking of Da Vinci Xi for robotic pancreatic resection. Intraoperative ultrasound of liver (bk5000, bkactiv, bkmedical, GE healthcare) was performed to exclude liver parenchymal metastasis followed by assessment of the baseline hepatic artery blood flow. A few nodes around the CHA were dissected followed by a trial of clamping of the CHA close to Gastroduodenal Artery (GDA) using a vascular clamp. The hepatic artery flow was reassessed using intraoperative doppler. Following a satisfactomy assessment of hepatic arterial inflow and measurement of Hepatic Arterial Resistive Index (HARI) with intraoperative Doppler ultrasound, ligation of the CHA was carried out with 3/0 prolene suture. Post ligation reassessment showed a good forward hepatic arterial flow with a mildly raised HARI (0.6 to 0.8) (Figure 5). Perioperative arterial blood gases also showed no significant change of postoperative lactate levels. Patient was discharged in 24 hours and the liver function on discharge showed a mild rise in ALT from 33 to 43 ug/l (Table 1). A repeat CT scan 10 days post stage 1 confirmed the vascularity to the liver and satisfactory collateral flows to liver through gastroduodenal artery and an absent flow from celiac artery trunk to liver (Figure 3).

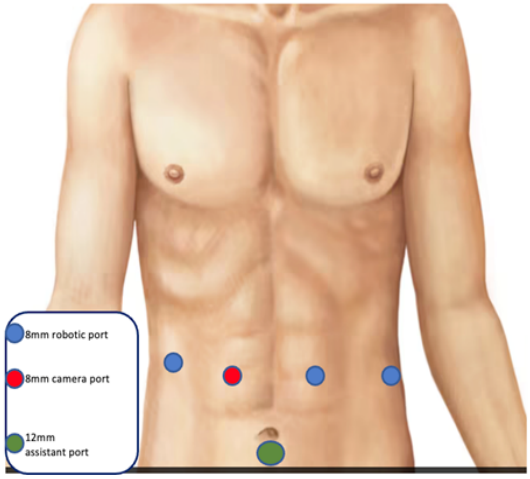

Figure 4: Port placement.

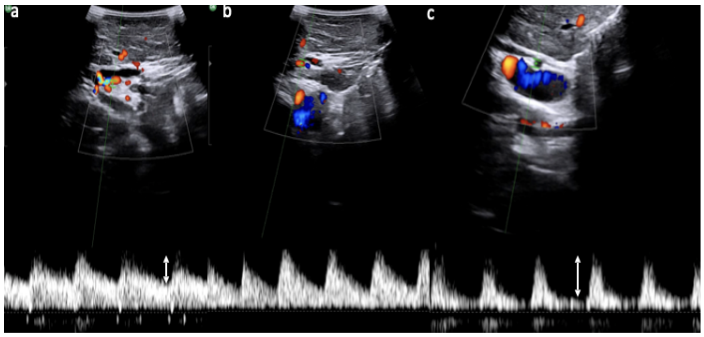

Figure 5: Intra-operative doppler and grey-scale ultrasound interrogation of the intrahepatic artery before (a) common hepatic artery clamping, after applying trial vascular clamp (b) and after ligation of common hepatic artery (c). Studies demonstrate that the intrahepatic arterial flow is maintained during trial clamping and after common hepatic artery ligation. As expected, the resistive index (peak systolic flow minus end-diastolic flow as a ratio of the peak systolic flow) increases (arrows a and c), however forward flow is maintained throughout the cardiac cycle.

	Baseline Preop	Stage 1		Stage 2					
		6 hrs post op	24 hrs postop	D0	D1	D2	D3	D4	D5
AST (u/l)	33	43	36	35	32	26	24	23	22
ALP (u/l)	151	120	126	169	142	139	161	186	239
Bilirubin (umol/l)	8	9	7	9	13	10	15	11	10
INR	0.9	1	1	0.9	1	0.9	0.9	0.8	0.8
Lactate (mmol/l)	0.8	0.9	0.8	0.9	0.8	0.8	0.9	0.8	0.8

Table 1: Liver function test.

Stage 2: Robotic RAMPS with en bloc celiac axis trunk and CHA resection.

Following a restaging CT scan of abdomen and pancreas showing a satisfactory appearance of liver and stable primary cancer, she underwent stage 2 operation with robotic RAMPS and en bloc celiac axis trunk and CHA resection 2 weeks post stage 1.

Via standard port placement using the same incision as in stage 1 with Da Vinci Xi, gastrocolic and gastrosplenic omentum were divided with robotic Vessel Sealer Extend (intuitive, USA) followed by incision of peritoneum in the infra pancreatic portion at the level of the neck of pancreas. A tunnel was created behind the neck of pancreas above superior mesenteric vein and this part of the pancreas above the tunnel was transected with an echelon 60mm stapler (Ethicon, USA). Following the division of the pancreas, the GDA was exposed and protected. CHA was then divided with endo GIA 45mm vascular cartridge (Ethicon, USA) at the point where it gives off GDA and continues as hepatic artery proper. Hepatic arterial flow was checked with intraoperative doppler once again with intraoperative ultrasound and doppler showing a satisfactory in flow. Splenic vein was dissected at the level spleno-porto-mesenteric confluence and divided using endo GIA 45mm vascular cartridge. Pancreas was mobilised in an antegrade fashion from the retroperitoneum. Then, careful dissection around the celiac trunk was achieved by dividing the celiac plexus of nerves followed by division of celiac trunk from aorta using echelon 60mm stapler. Haemostasis was checked at this point. Then, the complete mobilization of pancreas and spleen was done from retroperitoneum together with left adrenalectomy. Specimen was extracted by using endocatch through umbilical port extension. A 20 FG Robinson drain was kept in the pancreatic bed after haemostasis. Umbilical port was closed with no. 0 loop pds and skin with 3-0 monocryl. Patient had uneventful postoperative period and discharged on postoperative day 5 after removal of the surgical drain.

Post operative histopathology showed a complete pathological response from chemotherapy and chemoradiation with no residual cancer. None of the 26 lymph nodes harvested showed any evidence of cancer. At her post operative follow-up, 4 weeks after discharge, she remained well. The repeat blood tests showed a normal liver function, haematology and a normal blood sugar ranging 6-7 mmol at 3 and 8 months respectively. Although she is still experiencing persistent grade 2 peripheral sensory neuropathy, she remains disease free at 8-month on surveillance CT chest and abdomen (Figure 1f) . Currently, she is planned for further 3 monthly surveillances with bloods, tumour markers and CT chest and abdomen. She is on Creon 50,000 units with each meal and vitamin D supplementation.

Discussion

Celiac artery resection with distal pancreatectomy and splenectomy for locally advanced pancreatic body cancers can achieve a high R0 resection rate of 92.2% [1,2] while the conventional distal pancreatectomy alone is insufficient [2]. Appleby described the en bloc resection of the celiac axis with a total gastrectomy and distal pancreatectomy for locally advanced gastric cancer in 1953 [3]. Since then, the original Appleby procedure has been modified for resection of locally advanced pancreatic body cancer by excluding gastrectomy [4]. This radical approach to pancreatic cancer has reported to show an estimated 5-year survival rate of 42.2% [1]. In addition, celiac artery resection gives immediate and long-lasting relief of abdominal and back pain from the disease by resecting the celiac nerve plexus. To achieve safe resection of celiac artery and to avoid postoperative ischaemic complications to hepatobiliary and gastric system, Kondo et al described two stage procedures with radiological embolization of common hepatic artery first followed by resection of pancreatic cancer with celiac axis trunk 2 weeks later [5,6]. In comparison to Appleby's operation, the advantage of Kondo procedure is that it allows time to develop collateralisations to liver and stomach

through gastroduodenal artery from superior mesenteric artery and avoids further need for reconstruction of arterial system and alimentary tract during celiac artery resection [7]. A lack of dynamic assessment of hepatic artery blood flow and irreversibility are the major drawback of this preoperative common hepatic artery embolization. The other drawback is non-therapeutic embolization in case of disease progression [8]. Gastric ischaemia/perforation were noted in patients who underwent celiac artery resection without preoperative common hepatic artery embolization [9,10]. To overcome this, we propose this staged celiac artery resection with pancreatosplenectomy coined as SCARPS operation. The major advantage of SCARPS is that it allows assessment of disease and real time hepatobiliary haemodynamic study prior to the ligation of common hepatic artery. The other advantage is that should there be any problem related to worsening liver function and raising lactate level suggestive of hepatic ischaemia following stage 1 operation one can contemplate stenting of common hepatic artery to rescue hepatic inflow. CT angiogram can be used post ligation of common hepatic artery to assess the hepatobiliary and gastroduodenal collateralizations. Stage 2 operation can be performed within 2 weeks of stage 1 operation consisting of en bloc celiac artery resection with radical RAMPS. The other major benefit of this procedure to patients is that it is designed fervently to be performed minimally invasively for quick recovery. In our case, both procedures were performed robotically with Da Vinci Xi system using the same port site incisions. Patient was discharged within 24 hours of stage 1 procedure, which is equivalent to the length of hospital stay after hepatic artery embolization. Our patient required little analgesia after stage 2 and discharged home on postoperative day 5.

There were very few reports of celiac artery resection with distal pancreatectomy and splenectomy using minimally invasive robotic approach [11-14] and some reported major complication rate of 35% in patients without prior ischaemic preconditioning [9]. This newly proposed two-stage robotic approach is a modification of two surgical procedures to allow safe ligation of common hepatic artery to avoid ischaemic hepatic and gastric injury following resection of celiac axis trunk and common hepatic artery without vascular reconstruction. For the first time, this two-stage minimally invasive approach is described to benefit patient for quick postoperative recovery. One of the limitations of this approach is that it is contraindicated when tumour involves the gastroduodenal artery and it involves two operations [7,14].

Conclusion

Staged celiac artery resection with pancreatosplenectomy (SCARPS) allows safe ligation of common hepatic artery with intraoperative hepatic haemodynamic study and assessment of disease status prior to major resection for locally advanced pancreatic cancer with celiac /common hepatic artery involvement. This can be done minimally invasively to benefit patients directly for quick recovery.

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