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ABSTRACT

Introduction
Vascular reconstruction is utilised following resections for pancreatic cancers with borderline resectability. This is defined by venous or partial superior mesenteric artery (SMA) involvement, where vessels are resected en-bloc to achieve an R0 resection.

There are many vascular reconstruction techniques post en-bloc R0 resection, each with its own complication profile. The splenic turndown technique separates the vascular anastomosis from the pancreatic anastomosis, reducing the risk of vascular disruption should a pancreatic leak occur.

Case Report
This is the first report in the literature of the splenic vein turndown technique being utilised for vascular reconstruction post pancreatic resection for borderline resectable pancreatic cancer. To date, splenic vein turndown repair has only been described in a trauma setting. In this case, splenic vein turndown was preferred as the patient was on long-term corticosteroids with a high risk of anastomotic leak.

Conclusion
This case reports the technique of splenic vein turndown, showing that it is a feasible option for vascular reconstruction post pancreatic resection. The main disadvantage of this technique is high risk of segmental portal hypertension if the spleen is not removed concomitantly. For this reason, its utility should be restricted to patients at high risk of pancreatic leak.

Keywords: Pancreatic cancer, venous reconstruction
TITLE: Splenic vein turndown for vascular reconstruction following pancreatic cancer resection in patients with high risk profile

INTRODUCTION
Patients with pancreatic cancer frequently have extra-pancreatic involvement at the time of diagnosis[1]. Portal vein (PV) - superior mesenteric vein (SMV) involvement is often seen on pre-operative imaging or at the time of resection. Surgical resection remains the only definitive treatment, increasing median survival from five to ten months without surgery to twenty three months with a negative margin (R0) resection[2]. The five year survival is approximately 20% when combined with adjuvant therapy. Katz and colleagues[3] reported a median survival of forty months for patients with borderline resectable disease who successfully completed neoadjuvant therapy, R0 resection and adjuvant therapy.

Failure to achieve a clear margin (R1) resection produces similar survival rates to chemo-radiation treatment alone with a median survival of eleven months[2]. Benefits of surgery depend on clear margins being obtained. In order to achieve R0 status, en bloc resection of the SMV during the pancreatic resection may be required followed by vascular reconstruction and gastrointestinal anastomoses.

Borderline resectability in pancreatic cancer is defined as no distant metastases, but with venous involvement of the SMV/PV - abutment and/or narrowing or encasement of the lumen but with suitable vessel proximal and distal to the area of vessel involvement (to allow for reconstruction), no involvement of celiac axis and no more than 180 degrees of circumferential involvement of SMA)[4].

A consensus statement from the American Hepato-Pancreatico-Biliary Association and Society of Surgical Oncology (AHPBA/SSO) in 2009 highlighted the importance of R0/R1 resection for pancreatic adenocarcinomas with venous vascular involvement of the PV/SMV[5], with little benefit from incomplete resections. The AHPBA/SSO recommended these resections be performed in high volume institutions with experience in resection and reconstruction of major mesenteric veins [5].

In this study, a case of a borderline resectable pancreatic adenocarcinoma has been reported. The seventy five year old female required a pancreaticoduodenal resection
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with en bloc resection of major vasculature. However, she had significant comorbidities and was on long-term high dose corticosteroids for polymyalgia rheumatica (PMR). Because of her steroids, co-morbidities and age, there was significant concerns of post-operative anastomotic leak, and a pancreatic leak disrupting a vascular anastomosis would have been catastrophic. Furthermore, even in the setting of neoadjuvant therapy, concern for pancreatic fistula was also considered, with rates in the order of 3% found in systematic reviews [6].

Following extensive discussions with upper gastrointestinal, vascular surgeons, oncologists and radiologists, a decision was made to perform a pancreatic resection and splenectomy with venous reconstruction using the splenic vein turndown technique.

Final histopathology confirmed an R0 resection with negative margins and at one year follow-up the patient had adequate flow and no evidence of recurrence. This is the first report in the literature of the splenic vein turndown technique being utilised for vascular reconstruction post pancreatic resection for borderline resectable pancreatic cancer. Currently, the splenic vein turndown repair has only been described for superior mesenteric vein trauma. This case shows that it may be considered in patients who have a high risk of anastomotic leak in patients requiring en block major vasculature resection in borderline resectable pancreatic cancer.

CASE REPORT

A seventy five year old female presented with abdominal pain and a new diagnosis of insulin dependent diabetes mellitus (IDDM). She had polymyalgia rheumatica and was on long-term steroids.

A triple phase Computed Tomography (CT) of the abdomen was performed revealing a twenty three millimetre (mm) lesion in the pancreatic head with a mass abutting the portal vein (PV). There was no thrombosis or encasement and no arterial involvement or evidence of metastatic disease. Endoscopic ultrasound (EUS) guided fine needle aspiration (FNA) biopsy confirmed the moderately differentiated adenocarcinoma (22x24mm) with abutment of the SMV /PV over one centimetre, associated with mild fusiform dilatation at the point of contact. She was assessed to have borderline resectable disease and was commenced on neoadjuvant
chemotherapy.

During the course of her treatment, she became jaundiced with a bilirubin of over two hundred micromole per litre (mmol/L) and proceeded to endoscopic retrograde cholangio pancreatography (ERCP) and stenting. Her Carbohydrate Antigen 19-9 (CA19-9) level was two hundred and sixty units per millilitre (U/mL). After 3 cycles of gemcitabine based chemotherapy, repeat imaging with CT scan and EUS revealed no progression or reduction in disease but her CA19-9 level decreased to 110 U/mL. Positron Emission Tomography (PET) imaging revealed no evidence of metastatic disease. Her case was referred to a high volume pancreatic surgery unit for consideration of resectability.

With good premorbid performance status, no evidence of metastatic disease, no disease progression while on neoadjuvant chemotherapy, and radiological evidence of resectability, the patient was offered a pancreaticoduodenectomy. Intraoperatively, the SMV and confluence of the jejunal and ileal venous tributaries was involved with the tumour but the portal vein was relatively free (see Figure 1.). There was no evidence of distant metastases. A decision was made to perform a total pancreatectomy with venous resection and reconstruction. Due to her chronic steroid use, the risk of leak was significantly higher. A decision was made to perform a splenic vein turndown technique to reduce the risk of an anastomotic leak disrupting the vascular reconstruction which would be catastrophic. A splenectomy was also performed to reduce the risk of segmental portal hypertension associated with the short gastric vessels in cases where the spleen is preserved.

Following cholecystectomy, distal gastrectomy, end-side hepaticojejunostomy and end-side antecolic gastrojejunostomy, a splenectomy was performed. The splenic vein was isolated and prepared for the turndown technique. During the course of the turndown technique, the PV, SV and 2 main tributaries of SMV (jejunal and ileal) were clamped and divided. The two SMV tributaries were then re-anastomosed to the mobilized and turned down splenic vein (see figure 2, 3 and 4.). 7-0 prolene suture was used to perform the anastomosis of the splenic vein to ileal and jejunal tributaries of the SMV, with a continuous end to side and end to end anastomosis respectively. Even in this setting of neoadjuvant therapy, the caliber of these vessels...
were reasonable and formed part of the patient's preoperative imaging assessment with regards to options for venous reconstruction. This included vascular surgeon review re suitability. This patient received 5000 international units (IU) of intravenous (IV) heparin cover, and had a total ischaemia time of 17 minutes. No blood products were used intraoperatively and the total operative time was 323 minutes. Final pathology confirmed a poorly differentiated adenocarcinoma in the head of the pancreas which was 35mm in diameter, extending to the anterior border. Tumour was found invading the wall of the SMV. 2/26 lymph nodes were involved. The pathological staging was pT3, pN1, Mx. The margin was negative and there was no evidence of residual microscopic disease. The patient had an uneventful recovery and proceeded to have adjuvant chemotherapy. Repeat imaging at three and six months post-surgery revealed no evidence of recurrent disease. Furthermore, post-operative imaging revealed patent flow through her anastomosis, with no functional limitation regarding the potential for angulation at the junction of the SV and SMV with this turndown technique (see figure 5.) The patient remains alive 42 months post resection.

DISCUSSION
There are many vascular reconstruction techniques including use of the splenic vein post pancreatic resection including use of the splenic vein. When the splenic vein has been used for reconstruction, it has been utilised as an autologous interposition graft in cases of pancreatic adenocarcinoma. The IJV may also be used as an autologous graft post pancreatic resection[7, 8]. There are a range of synthetic grafts. In this case, rather than using the splenic vein as an interposition graft, the splenic vein turndown technique is a novel technique. Splenic vein turndown preserves the splenic-PV confluence and utilizes the proximal splenic vein to anastomose the jejunal and ileal tributaries, preserving intestinal venous drainage. The use of a splenic vein turndown technique has been successfully described in cases of SMV/PV trauma [9]. Phillips and colleagues reported the use of the turndown technique in one patient to repair SMV traumatic avulsion, and in a literature review of 56 articles, identified five other trauma cases where the splenic
vein turndown repair was used. Of the six patients, four survived the procedure with radiological evidence of portal venous flow post operatively[9].

In a review of Pubmed, EMBASE and Google Scholar, using search terms including “splenic vein turndown” and “pancreatic cancer” or “pancreatic malignancy” or “pancreatic resection”, there were no results. To the best of our knowledge, this is the first report in the literature of the splenic vein turndown technique being utilized for reconstruction post pancreatic resection for malignancy.

The splenic vein turndown technique has several limitations. Without a concomitant splenectomy, there is a high risk of segmental portal hypertension and gastric varices over time. Perigastric varices and submucosal varices detected by CT have been reported to be as high as 70% and 20% respectively. It may also cause gastric haemorrhage and intractable bleeding, although this is rare. Splenic vein obliteration post spleen preserving distal pancreatectomy has also been described as a possible complication [10].

Although performing a splenectomy reduces the risk of segmental portal hypertension, splenectomy is not without its own risks, including the risk of overwhelming post splenectomy sepsis and the need for appropriate vaccinations and long term antibiotics.

**CONCLUSION**

This case demonstrated the successful application of a splenic vein turndown technique for SMV reconstruction following pancreaticoduodenectomy and venous resection for pancreatic cancer. The technique may be considered in high risk patients who are at significant risk of anastomotic leak such as for patients with long term corticosteroids or immunosuppressants, as it separates the vascular anastomosis from the pancreatic anastomosis, thus reducing the risk of a potential pancreatic leak disrupting the vascular anastomosis.

**CONSENT**

Written informed consent was obtained from the patient prior to publication.
CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

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AUTHOR’S CONTRIBUTIONS

EC and NM were involved in the preparation of the manuscript. JI, JT and AM were involved in writing the discussion of this study. JWTT was responsible for reviewing and main editing of the article. All authors approved the article prior to publication.

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List of Abbreviations

SMA superior mesenteric artery
PV portal vein
SMV superior mesenteric vein
HA hepatic artery
AHBA/SSO American Hepato-Pancreatico-Biliary Association and Society of Surgical Oncology
IDDM insulin dependent diabetes mellitus
CT computed tomography
mm millimetres
REFERENCES


FIGURE LEGENDS

Figure 1: Intraoperative photograph of venous structures encountered during splenic vein turndown technique

Figure 2: Left – venous anatomy in pancreaduodenectomy. Right – venous anatomy post splenic vein turndown with anastomosis of ileal and jejunal veins with total pancreatectomy and splenectomy (PV = portal vein, SMV = superior mesenteric vein, JB = jejunal branch, IC = ileocolic branch).

Figure 3: Splenic vein turn-down with anastomosis

Figure 4: Intraoperative photograph of splenic vein turndown technique with SMV ligated, and splenic vein anastomosed to jejunal and ileal branches

FIGURES

Figure 1: Intraoperative photograph of venous structures encountered during splenic vein turndown technique
Figure 2: Left – venous anatomy in pancreaduodenectomy. Right – venous anatomy post splenic vein turndown with anastomosis of ileal and jejunal veins with total pancreatectomy and splenectomy (PV = portal vein, SMV = superior mesenteric vein, JB = jejunal branch, IC = ileocolic branch).

Figure 3: Splenic vein turn-down with anastomosis
Figure 4: Intraoperative photograph of splenic vein turndown technique with SMV ligated, and splenic vein anastomosed to jejunal and ileal branches.
Figure 5: CT 3 months post total pancreatectomy and splenic turndown reconstruction demonstrating patent flow through portal vein and ileal and jejunal tributaries