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Distal Pancreatectomy with Celiac Axis Resection (Modified Appleby Procedure) and Arterial Reconstruction for Locally Advanced Pancreatic Adenocarcinoma After FOLFIRINOX Chemotherapy and Chemoradiation Therapy

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ABSTRACT

Background. Resectability of pancreatic carcinoma (PC) is directly linked to vascular extension (Tempero MA et al. in *J Natl Compr Canc Netw* 15(8):1028–1061, 2017. <http://doi.org/10.6004/jnccn.2017.0131>; Isaji S et al. in *Pancreatology* 18(1):2–11, 2018. <https://doi.org/10.1016/j.pan.2017.11.011>). Involvement of the celiac axis (CA) is typically a contraindication to surgery. High postoperative morbidity and subsequent poor prognosis have been observed in this case, especially for contact > 180° requiring arterial resection (Tempero MA et al. 2017). Recent medical advances in PC treatment, such as FOLFIRINOX-based chemotherapy eventually followed by chemoradiation therapy, offer the potential to select tumour for surgery and to obtain a negative-margin resection even in case of unresectable PC at diagnosis (Suker M et al. in *Lancet Oncol* 17(6):801–10, 2016. [https://doi.org/10.1016/s1470-2045\(16\)00172-8](https://doi.org/10.1016/s1470-2045(16)00172-8); Pietrasz D et al. in *Ann Surg Oncol* 26(1):109–117, 2019. <https://doi.org/10.1245/s10434-018-6931-6>). A major pathologic response has been

observed in more than 20% of patients after this treatment and is associated with an improved survival (Suker M et al. 2016; Pietrasz D et al. 2019). This evolution allows aggressive surgical strategies with the possibility of long-term disease control for patients showing a good response to induction treatment.

Patient. This video presents the case of a 66-year-old man diagnosed with a locally advanced ductal adenocarcinoma of the pancreatic body with a 360° involvement of the CA and the hepatic artery. After eight courses of FOLFIRINOX chemotherapy and a capecitabin-based chemoradiation, a surgical exploration was planned for potential resection.

Technique. The key steps of the procedure are presented, i.e. surgical exposition, assessment of resectability with frozen sections of peri-arterial tissues, *en bloc* resection (Strasberg SM et al. in *Surgery* 133(5):521–527, 2003. <https://doi.org/10.1067/msy.2003.146>), and primary end-to-end arterial reconstruction.

Conclusion. A modified Appleby operation for locally advanced PC is a technically challenging but feasible procedure in experienced teams. It offers the possibility of *en bloc* R0 resection of a locally advanced PC with the potential of long-term disease local control. This video may help surgeons to perform this complex intervention.

have been observed in this case, especially for contact $> 180^\circ$ requiring arterial resection.¹ Recent medical advances in PC treatment such as FOLFIRINOX-based chemotherapy eventually followed by chemoradiation therapy offer the potential to select tumour for surgery and to obtain a negative-margin resection even in case of unresectable PC at diagnosis.^{3,4,5} A major pathologic response has been observed in more than 20% after this treatment and is associated with an improved survival.^{3,4} This evolution allows aggressive surgical strategies with the possibility of long-term disease control for patients showing a good response to induction treatment.

Appleby described the first CA resection in locally advanced gastric cancers in 1953.⁶ The procedure included *en bloc* gastrectomy, distal pancreatectomy, and splenectomy associated with the resection of the CA and the hepatic artery (HA) proximal to the gastroduodenal artery (GDA). Liver vascularisation is then based on the retrograde arterial blood flow through the GDA and also on the possibility of an aberrant HA emerging from the superior mesenteric artery (SMA) or a preserved left gastric artery.⁶ However, a risk of severe liver ischemia and gallbladder necrosis was reported in the postoperative period.⁶ The modified Appleby procedure was subsequently described in 1976 by Nimura et al. for locally advanced body or tail PC, allowing *en bloc* resection of the CA and the tumour without gastric resection.^{7,8} As in the original procedure, the liver arterial supply is also based on the retrograde blood flow from the SMA through the pancreaticoduodenal arcades and the GDA. If the perfusion is not adequate, the common HA needs to be reconstructed to prevent the complications of hepatic ischemia.

To overcome this issue, preoperative embolization of the common HA to enlarge the collateral pathways has been described and is currently recommended.⁹ Distal pancreatectomy with CA resection is then frequently performed without arterial reconstruction after preoperative embolization and its risks, including postoperative arterial hemorrhage or thrombosis. HA embolization is currently associated with embolization of the splenic and left gastric arteries to reinforce perigastric arcades limiting postoperative ischemia of the stomach. However, recent series observed a residual risk of liver and/or biliary ischemia in the postoperative period, and also a high rate of pancreatic leak.¹⁰ Cholecystectomy is then recommended to avoid postoperative necrotic cholecystitis. If the peroperative evaluation of the liver perfusion through the GDA is not adequate, or in case of peroperative damage to the pancreaticoduodenal arcades, arterial reconstruction is required to prevent hepatic or gastric ischemia. In this case, arterial reconstruction may be compromised by preoperative embolization leaving coils in the CHA.

The alternative of the preoperative embolization strategy is the arterial reconstruction showing interesting surgical outcomes with R0 resection and primary arterial anastomosis or graft bypass.^{11–14} Various approaches to vascular reconstruction have been described in the literature. In our experience, an end-to-end primary arterial anastomosis was possible in the majority of cases, between the aorta or the CA stump and the remaining HA without venous or prosthetic graft interposition. This primary reconstruction is particularly feasible if a residual CA stump remained after a margin-negative resection, as shown in the presented video. Direct reconstruction between different arterial supplies (the middle colic artery, a conserved left gastric artery, or an iliac external artery) and the proper HA have also been described.¹⁴ Arterial reconstruction allows an arterial supercharge of the liver inflow without compromising arterial vascularisation of the pancreaticoduodenal region. Primary anastomosis is preferable to interposition grafting along the pancreatic stump to reduce infectious or thrombotic complications and to reduce the number of arterial anastomoses. If direct anastomosis is not feasible, a graft bypass is required. In this case, an autologous graft using the saphenous vein or the inferior mesenteric vein is preferred to the interposition of a synthetic graft besides the pancreatic stump. In all cases, patient selection, attentive analysis of vascular anatomy, and management in experienced centres are the key steps of this procedure.

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