Ex Vivo Resection and Autotransplantation for Pancreatic Neoplasms

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KEYWORDS

• Pancreas • Pancreatic tumors • Ex vivo resection • Autotransplantation
• Mesenteric root involvement • SMA involvement

KEY POINTS

- Ex vivo resection and autotransplantation is a technique derived from multivisceral and intestinal transplantation whereby tumor-infiltrated organs are removed en bloc and preserved in the cold, followed by tumor resection and reimplantation of the remaining viscera.
- Advantages of ex vivo resection include tumor removal in a bloodless field while minimizing the risk of ischemic injury to the involved organs.
- Access to the mesenteric root is greatly facilitated with ex vivo resection, and allows for safe reconstruction of major vasculature while preserving visceral integrity.
- Certain low-grade, non-adenocarcinomatous pancreatic neoplasms involving the mesenteric vessels where aggressive surgical resection would be warranted, may benefit from ex vivo resection.
- Although ex vivo resections have been performed for pancreatic adenocarcinomas with major arterial involvement, the associated morbidity is significant and benefit remains unclear.

INTRODUCTION

Pancreatic neoplasms are a heterogeneous group of tumors arising from the pancreas with distinct and varied clinical profiles.[1] Although pancreatic adenocarcinoma remains by far the most common and deadliest of these, there are several low-grade or benign neoplasms that may benefit from aggressive, curative resection.[2,3] Due to the proximity of the pancreas to major abdominal vasculature, these tumors can sometimes infiltrate these vessels and preclude complete or safe resection by conventional surgical technique. Ex vivo resection and autotransplantation, whereby

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tumor-laden viscera are explanted and reimplanted following tumor removal in cold preservation, allows the possibility of complete resection and vascular reconstruction while minimizing organ injury and obviating the need for allotransplantation.[4]

Ex vivo surgery was first described in 1963 for the reimplantation of a kidney following a high ureteral injury.[5] In 1988, Rudolf Pichlmayr and colleagues[6] successfully described the first ex vivo tumor resection for large liver neoplasms located at the confluence of the hepatic veins. Although radical pancreatectomy with vascular reconstruction had been previously performed for tumors invading the mesenteric vessels,[7] further experience in multivisceral transplantation led to the first successful description of ex vivo resection and intestinal autotransplantation for a large fibroma located in the head of the pancreas invading the mesenteric root by Andreas Tzakis and colleagues.[8] Since then, more than 40 cases of ex vivo tumor resection and intestinal autotransplantation have been reported worldwide for tumors involving the superior mesenteric vessels, and 32 of these involved pancreatic neoplasms.[9] Additionally, our institution has reported 2 multivisceral ex vivo resections with combined liver, intestinal, and pancreas autotransplantation for pancreatic tumors involving both the superior mesenteric artery (SMA) and the celiac axis.[10]

The technique of ex vivo surgery, which involves the explantation of all tumor-associated organs and tumor removal in cold preservation, allows for safe and complete resection or separation of critical vascular structures while minimizing ischemic organ injury. Exposure to these mesenteric vessels is also significantly improved in a bloodless field, where the organ bloc can be flipped over and easily manipulated.[11] Most importantly, ex vivo surgery can help facilitate the safe reconstruction of critical vasculature while ensuring visceral preservation. For certain pancreatic tumors, this technique could help prevent the need for allotransplantation and its associated morbidities.[12]

The ideal candidate for ex vivo surgery is a patient with a low-grade or benign yet symptomatic mass involving the mesenteric vessels that is not feasible with conventional surgical or vascular reconstructive techniques. Symptoms are often nonspecific, but patients can present with abdominal pain, difficulty eating, and signs of intestinal or biliary obstruction, or of portal hypertension. Several pancreatic tumor types have been successfully resected using ex vivo techniques with excellent long-term outcomes, including pancreatic fibromas,[8] desmoid tumors of the pancreas,[8] solid pseudopapillary tumors,[9] pancreatic neuroendocrine tumors,[9] ganglioneuromas,[13] serous cystadenocarcinomas,[14] inflammatory myofibroblastic tumors, and hemangioendotheliomas.[10]

Most of these tumors are located at the head of the pancreas and therefore amenable for pancreaticoduodenectomy. A few occur diffusely throughout the entire gland, and require total pancreatectomy to achieve complete resection.[10]

The benefit of ex vivo resection in patients with pancreatic adenocarcinoma involving the SMA is unclear.[14–16] Although surgical resection of all gross disease has traditionally been the best hope for long-term survival, aggressive surgery for disease that has already spread to encase the mesenteric arteries is controversial. In a meta-analysis by Mollberg and colleagues,[17] patients who underwent arterial reconstruction during pancreatectomy exhibited higher perioperative mortality and poorer 1-year and 3-year survival compared with patients who underwent pancreatectomy without vascular reconstruction or with venous reconstruction only. However, patients who underwent arterial reconstruction were associated with longer survival than patients with locally advanced disease who did not undergo pancreatectomy altogether.

For patients with locally advanced pancreatic adenocarcinoma, ex vivo resection can theoretically provide a means to completely resect all gross disease, including the involved vasculature. But due to the high likelihood of micrometastatic disease at the time of diagnosis, tumors that have already encased the SMA would almost