Imaging of Pancreas Transplantation and Its Complications

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KEYWORDS

• Pancreas transplant • Complications • Rejection • Pancreatitis • Vascular thrombosis • Pancreas kidney transplant

KEY POINTS

- Anatomic detail of pancreatic transplantation is complex and requires consideration of endocrine and exocrine drainage of the pancreatic graft.
- The venous drainage can be via a systemic pathway or portal pathway, whereas the exocrine drainage can be through the bladder or enteric pathways.
- Pancreatic transplantation is associated with several complications, which could be related to vasculature, the pancreatic parenchyma, or related to other surgical factors.

INTRODUCTION

Whole organ pancreas transplantation is an accepted and valid therapeutic option for patients with insulin-dependent diabetes mellitus (type 1 and type 2), or patients who have undergone prior total pancreatectomy. By eliminating the need for daily glucose monitoring and insulin administration, pancreas transplantation can significantly improve quality of life, while also preventing life-threatening complications associated with hypoglycemic unawareness (lack of warning symptoms associated with hypoglycemia). Moreover, transplantation is the only long-term treatment of diabetic patients that can attain insulin-free euglycemia, and prevent, reverse, or delay the onset of end-organ complications such as retinopathy, nephropathy, and coronary artery disease.[1] For patients with diabetes and renal insufficiency, combining pancreas and kidney transplant has also been shown to increase long-term survival.[2]

Approximately 80% of pancreas transplants are performed as simultaneous pancreas-kidney (SPK) transplants; however, they can also be performed successfully as pancreas after kidney (PAK) transplants or as pancreas transplant alone (PTA).[1] SPK transplant is ideal for most patients, particularly those younger than 55 with renal insufficiency, resulting in better graft success due to the ability to use serum creatinine to concurrently monitor both transplants for rejection.[3] PAK transplant offers the ability to perform a living donor renal transplant followed by a deceased donor pancreas transplant, thus reducing time spent on the transplant waiting list for 2 organs. PTA is only appropriate for a minority of patients who have severe hypoglycemic unawareness and preserved renal function. Patients who have SPK transplantation have improved 10-year survival compared with diabetic patients receiving kidney transplantation alone, with 23.4 years versus 12.9 years, respectively.[4]

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During graft procurement, the pancreas is removed along with a variable length of intact duodenal C-loop. Because the gastroduodenal artery is usually divided during liver procurement, pancreas transplant arterial supply primarily consists of the superior mesenteric artery and splenic artery and their branches.[2] To perform the arterial reconstruction, the donor iliac artery bifurcation is most commonly procured simultaneously for vascular reconstruction as a Y graft. The donor common iliac artery (stem of the Y graft) is anastomosed end-to-side to the recipient common iliac artery, while the donor internal and external iliac arteries (limbs of the Y graft) are anastomosed end-to-end to the stumps of the splenic and superior mesenteric arteries of the transplanted pancreas (**Fig. 1**).

Venous drainage of the pancreas transplant consists of intrapancreatic tributaries that drain into the splenic vein, superior mesenteric vein, and portal vein.[2] The donor portal vein can be anastomosed to the recipient inferior vena cava or iliac vein (systemic drainage), or the superior mesenteric vein (portal drainage). Bypassing the liver in systemic venous drainage can result in systemic hyperinsulinemia, which is thought to adversely affect lipid metabolism and predispose patients to accelerated atherosclerosis, although this has never been shown to be induced by a pancreas transplant or to result in higher cardiovascular mortality.[3,5] By mimicking native pancreatic venous drainage and preserving hepatic first-pass insulin clearance, the portal drainage technique has been purported to be more physiologic but has not been shown to result in better long-term outcomes regarding graft survival, function, rejection rate, or metabolic profile[5,6] (**Fig. 2**). As such, the technique is dictated by donor and recipient anatomy in conjunction with the individual surgeon's preference[1] (**Fig. 3**).

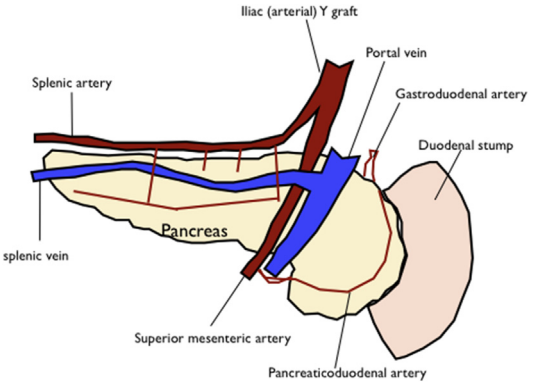

Fig. 1. Explanted pancreas from the donor. The graft is prepared in sterile lactated Ringer at 4-degrees Celsius. Excess tissue, especially fat, is separated from the pancreatic graft. The pancreatic head is supplied by the inferior pancreaticoduodenal artery via the superior mesenteric artery (SMA), and the body and tail are supplied by the splenic artery. The Y graft is connected to SMA and celiac artery proximally to provide a single common arterial conduit to be grafted to the recipient iliac artery. Venous drainage will be established via a portion of the harvested donor portal vein, which connects the superior mesenteric vein (SMV) and splenic vein.

Historically, pancreas transplants used the bladder for exocrine drainage via a duodenocystostomy.[7] Bladder drainage offers several advantages, including the ability to assess graft exocrine function by measuring urinary amylase and also access for cystoscopic biopsy. However, this nonphysiologic communication also results in complications due to the inflammatory nature of pancreatic enzymes. These complications include chemical cystitis, hematuria, metabolic acidosis, leak from the duodenal segment, recurrent urinary tract infections, urethritis, and urethral strictures.[8] As a result, nearly 90% of pancreas transplants now use enteric drainage with the donor duodenum anastomosed to a nonexcluded loop of recipient small bowel or a Roux limb.[1] If the pancreas is taken from a live donor, it is divided at the neck, and the donor splenic artery is anastomosed end-to-side to the recipient iliac artery, and the donor splenic vein is anastomosed to the recipient iliac vein (**Table 1**).

Imaging assessment of a pancreatic transplant requires a thorough understanding of these surgical techniques and the postoperative anatomy, as well as knowledge of the postoperative complications.[9,10] To properly evaluate the graft, radiologists must also recognize that the position of the pancreas transplant varies depending on the surgical technique. Pancreas transplants are most commonly placed intraperitoneally into the right pelvis, whereas the kidney is typically placed extraperitoneally into the left iliac fossa.[2] Grafts using systemic venous drainage are typically placed obliquely with the head inferior to the body and tail, whereas portal venous drainage most commonly requires the head-tail positioning to be reversed and more vertically oriented.[2]

Ultrasonography (US) is the usual first-line imaging modality for evaluation of the transplanted pancreas and its associated vasculature. A complete examination includes grayscale and duplex Doppler imaging. The normal graft on grayscale US should have a homogenous echotexture usually lower than that of the native pancreas and the surrounding fatty tissue[11] (**Fig. 4**). However, the position of the pancreatic transplant makes