

ORIGINAL ARTICLE

Revascularization of the gastroepiploic artery in pancreas transplant*

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Summary

Thrombosis accounted for 52.0% of all transplant failures in one recent large series and is felt to result from devascularization of the pancreas during organ procurement. A technique to revascularize the pancreas is described. The operative notes and angiograms of 110 consecutive pancreas transplants were reviewed. Eight pancreata were found deprived of blood supply to the head and the neck of the pancreas on indigocarmine-renograffin table angiograms. During back table reconstruction a distal branch of the superior mesenteric artery (SMA) was dissected and anastomosed end to end to the gastroepiploic artery using 8–0 monofilament suture. Repeated table angiogram showed excellent blood supply to the head of the pancreas, the duodenum and the body and tail of the pancreas. The pancreas transplantation proceeded with iliac artery graft inflow, portal venous outflow and enteric drainage. Simultaneous quadruple therapy with thymoglobulin, CNI, MMF and a 4-day course of steroids was used. All patients became insulin independent and euglycemic. No duodenal leak was observed in the entire series. In summary, ligation of the gastroduodenal artery (GDA) is not a safe procedure, especially when arterial blood supply from the inferior pancreaticoduodenal artery is poor or inexistent, 2-table angiogram helps delineate the high risk hypo-perfused pancreas, 3-preservation of the right gastroepiploic artery and the branches of the SMA allows an easy revascularization of the pancreatic graft.

Introduction

Pancreas transplant is the most physiologic therapy for the diabetic patient. Despite over two decades of experience and the considerable refinements in the surgical techniques, the operation still carries a high morbidity. In one recent review of a large series of 937 pancreas transplants, 123 grafts or 13.1% were lost for technical reasons such as thrombosis (52%), infection (18.7%) and leak (6.5%) [1], figures similar to those reported in the pancreas transplant registry [2].

We theorized that these complications result from the devascularization of the pancreas allograft during the combined liver-pancreas procurement. Since the liver is a 'life saving organ' and the pancreas transplantation only a

'life enriching' procedure, the liver team basically took the aortic patch carrying the common hepatic artery, divided the gastroduodenal artery and the splenic artery. In the worst scenario, the dorsal pancreatic artery also called the great superior pancreatic artery of Haller [3–5], the common inferior pancreatic artery and the inferior pancreaticoduodenal artery were divided or injured, especially when the aberrant right hepatic artery arises from the superior mesenteric artery (SMA). The absence of the two pancreatic arteries leads invariably to pancreas ischemia and arterial thrombosis [5]. This renders more tenuous the anastomosis between the head of the pancreas with its duodenal arcades and those of the body and tail of the pancreas by way of the dorsal pancreatic artery (Fig. 1) hence, the thrombosis of the pancreas. A

technique to improve the blood supply of the head, body and tail of the pancreas is described.

Materials and methods

During the first step, the operative notes and 118 consecutive table angiograms performed in our center since 1995 were reviewed. All pancreata underwent bench vascular reconstruction using $\times 2.5$ magnification. The donor iliac Y graft was anastomosed to the splenic artery and the SMA stumps. Halves of the anastomoses were run over and over with 7-0 polypropylene over a temporary five French feeding tube to avoid coaxial rotation of the anastomoses or 'catching' the posterior walls. The second halves of the anastomoses were performed with interrupted sutures. All sutures were tied at once after their insertion. The pancreas was defatted using the laparoscopic vascular stapler Endo GIA 60–2.5 (Autosuture, Norwalk, CT, USA). The duodenum was stapled 3 cm proximal and distal to the sphincter of Oddi located by a probe passed into the common bile duct using the Endo GIA 60–3.5 (Autosuture). One hundred cubic centimeters of University of Wisconsin solution with 100 cc of Renograffin stained with two ampoules of indigocarmine solution were used for table angiogram and flushed out. All leakages stained in blue were controlled again. Only

fully stained duodenopancreata were transplanted. Ten pancreata failing the test were discarded.

This review stimulated us to embark on a program of revascularizing the pancreas in February 2005 and to change the protocol of organ procurement. A close long-distance telephone discussion was established between the liver procurement team and the pancreas transplant surgeon with exact description of the size and the location of the severed dorsal pancreatic artery. The branches of the SMA to the mesenteric border and the right gastroeiploic artery were also preserved for future use (Fig. 1). Only after these conditions were met that the pancreas was accepted and benched. A distal branch of the SMA was dissected out to reach without any tension the right gastroeiploic artery (six cases) and the gastroduodenal artery (two instances). The remainder of the SMA and vein branches were stapled. The two vessels were anastomosed end to end to widely spatulated arteriotomies (Fig. 2). In the last two cases, two short segments of the SMA branches were used to reach the GDA without tension. Another table angiogram was repeated to assure that the neck and the body were well perfused. Despite this extensive bench work, the operating time took only 90–120 min to complete with the use of the laparoscopic staplers. The pancreas transplant just reconstructed was transplanted with portal vein draining into the superior mesenteric vein, side to side jejunostomy and the arterial Y graft connected to a punch out arteriotomy of the right common iliac artery or the proximal aorta. The *in situ* vascularized gastroeiploic artery was shown in Fig. 3. Simultaneous quadruple therapy with thymoglobulin, tacrolimus, mycophenolate mofetil and 4-day course of steroid was used. The renal allograft was transplanted in

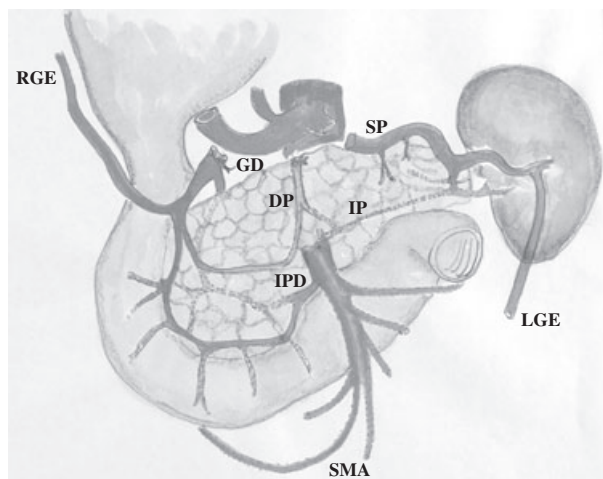


Figure 1 Schematic drawing of the arterial blood supply to the pancreas transplant showing the tenuous blood supply to the neck and the body of the pancreas. RGE, right gastroepiploic artery; GD, gastroduodenal artery; SP, splenic artery; DP, dorsal pancreatic artery, or superior pancreatic artery of Haller bridging the duodenal arcade and the body/tail of the pancreas vessels; IPD, inferior pancreatic artery or transverse pancreaticoduodenal artery; SMA, superior mesenteric artery; LGE, left gastroepiploic artery; IPD, common inferior pancreaticoduodenal artery.

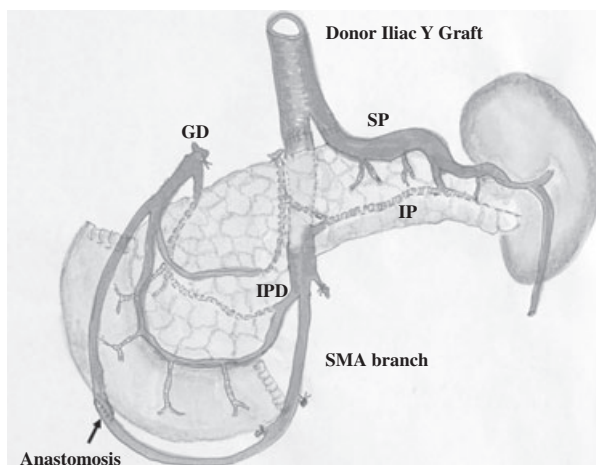


Figure 2 Schematic representation of the revascularized right gastroepiploic artery with a branch of the superior mesenteric artery. In two instances the gastroduodenal artery was used instead.

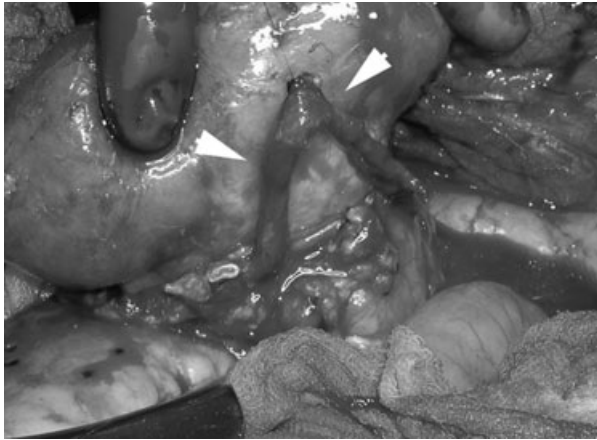


Figure 3 *In situ* vascularized gastropiploic artery (arrows).

the right iliac quadrant [6] saving the left side for future use.

Results

All pancreata reperfused well and became pulsatile throughout the whole pancreaticoduodenal splenic composite graft. The few bleeders that escaped the low-pressure indigocarmine angiogram were controlled. No blotching of the pancreas was observed. The duodenum was rapidly distended by exocrine pancreatic secretions requiring at time needle aspiration. The spleen was removed before transplanting the kidney in the right lower quadrant. A drain was inserted along the pancreas for 2–3 days. Despite the use of octreotide intravenously, prior to revascularization and continued for three days, chemical pancreatitis from reperfusion injury occurred invariably but resolved rapidly without ill effects. A single shot of 2000 international units of antithrombin III (Thrombate®; Talecris Biotherapeutic Inc, Research Triangle Park, NC, USA) was used recently in one patient. Four vascular thromboses occurred in the entire series of 108 consecutive cases, none in the eight cases of arterial revascularization described herein. No duodenal leak was observed. All patients became insulin independent and euglycemic (blood sugar levels under 120 mg/dl) 53% within 6 h, 26% between 6–12 h and 21% between 12–24 h. Average cold ischemic time was 16+/-3 h. No duodenal leak was observed in the entire series of 108 well-vascularized pancreata.

Discussion

The basic arteries to the duodenopancreas, i.e. the gastroduodenal artery, the common inferior duodenopancreatic artery arising from the proximal SMA, the inferior pancreatic artery (transverse pancreatic artery) and the splenic

artery collaterals are constant in 95–98% according to anatomical descriptions [5,6]. They unfortunately are fairly small, about 2 mm in diameter and are distributed in two territories around the head of the pancreas duodenum with its rich cephalic arcades, and the body and tail of the pancreas supplemented by small branches of the splenic artery and the inferior transverse pancreatic artery. The two were joined together by small collateral of the gastroduodenal artery and a dorsal pancreatic artery, which can be as large as 5 mm in diameter. This artery can take off from the common hepatic artery or the proximal splenic artery, is present in only 50% of cases and is not described in any of the standard textbooks [5]. Its rich connections with the gastroduodenal artery arcades, the common inferior pancreaticoduodenal arcade and the transverse pancreatic artery keep the whole pancreas allograft well vascularized. Its severance during organ procurement exposed the head, neck and body of the pancreas to ischemia leading to primary arterial thrombosis then secondary venous thrombosis from low velocity.

Table angiogram performed with perfusate stained with indigocarmine can resolve this dilemma by delineating the blood supply to the whole allograft and showing the ischemic nonstained areas with the missing vessel, which calls for revascularization. It further identifies the leakage sites from small vessels transected during organ procurement which can be ligated to lessen blood loss after reperfusion. Postbench reconstruction table angiogram helps assess the quality of the arterial reconstruction.

The dissection of the distal branches of the SMA can be tedious during bench surgery despite the thickness of the artery. A widely spatulated distal branch anastomosis to the gastropiploic artery (six cases), or a long remnant GDA (two cases) performed with continuous 8-0 polypropylene only took 10 min to perform.

The first attempt at revascularizing the gastroduodenal artery was by Han, who reported a case of side to end splenic artery to the gastroduodenal artery by way of a graft to the donor external iliac artery [7]. Later a more complicated triple arterial reconstruction was performed using the side to end anastomosis between the gastroduodenal artery and the donor external iliac artery [8,9]. In all reports no angiogram was performed before and after vascular reconstruction and no reason for revascularization was given. Furthermore, long-term patency was not discussed, but on the technical standpoint it would be difficult to achieve when a large and thick vessel, e.g. the external iliac artery is anastomosed to a short small and thin walled gastroduodenal artery.

Pancreas table angiography was introduced by Nghiem in 1998 and showed absence of the inferior pancreaticoduodenal artery in two grafts and absence of both dorsal pancreatic and inferior pancreatic arteries in the third

out of a series of 21 cases, for an incidence of 14.2% of arterial hypo-perfusion of the pancreas [10]. The technique described hereby focused selectively on this 10–14% of the pancreata which did not receive enough blood supply and which need to be revascularized. Again the technique of revascularization is not demanding.

As stated above, transient chemical pancreatitis from reperfusion injury is to be expected and is not harmful to the pancreas. The single shot antithrombin therapy advocated by some authors is interesting [11]. It has not led to bleeding despite the 3.8 days half-life of antithrombin and the absence of plasma antithrombin level monitoring as performed in our study [12]. It has improved significantly the rate of thrombosis from 24% to 16%, which is still very high as compared to our series.

In summary

Ischemia from organ procurement devascularization accounts for a high rate of thrombosis and enteric leaks in pancreas transplant.

The blood supply to the pancreas should be recognized by the recovery surgeon, and the information passed to the recipient surgeon. Preservation of the right gastroeiploic artery, the GDA, and distal branches of the SMA provides ways to revascularize the pancreas allograft in case of need.

Back table indigocarmine angiogram should be routinely performed to assure that the 'life enriching' organ is a well vascularized 'life saving organ' since it avoids catastrophic enteric leakages and peri-transplant abscess arising from necrotic ischemic pancreata.

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