Monitoring of Pancreas-Graft Perfusion by Radionuclide and Digital Subtraction Angiography

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The vascularity of a kidney transplant can be evaluated by intravenous radionuclide angiography. A normal functioning transplant should have an isotope histogram with a well-defined peak. Accordingly, a transplanted pancreas may be evaluated in the same way. By intravenous digital subtraction angiography and small amounts of contrast medium, arterial and venous structures can be visualized without catheterization of the arterial system. Five patients had combined kidney and pancreas transplantation. Intravenous angiography with 99m Tc-pertechnetate was performed three times a week for the first 5 postoperative wk. Digital subtraction angiography with an intravenous bolus of 80 ml of a low-osmolar nonionic contrast medium (iopamidol) was performed late in the postoperative course or when severe impairment of pancreas-graft perfusion was discovered by radionuclide angiography. One patient had two episodes and three patients one episode of rejection of both kidney and pancreas. Impairment of the pancreas-graft perfusion always preceded or was associated with deterioration of the graft function. In all patients, digital subtraction angiography demonstrated the graft vessels in sufficient detail. No thrombotic complications were observed. We conclude that these two methods can be used for monitoring the kidney and pancreas-graft perfusion. The methods may be of great value, especially in the early postoperative period, when problems with organ function are frequent and early intervention is essential. Diabetes 38 (Suppl. 1):21–23, 1989

The major complications in pancreas transplantation are rejection and thrombosis of the graft vessels. Early detection and treatment of these complications are of great importance, because the islet cells may be irreversibly damaged early in the course. When transplantation is combined with kidney transplantation, rejection may be diagnosed by monitoring the kidney function and perfusion. However, thrombosis of the pancreas-graft vessels cannot be diagnosed by observing the kidney graft, and within recent years, transplantation of the pancreas alone has become more frequent. Monitoring of the pancreas-graft function by plasma glucose or C-peptide concentration is insufficient, because an elevation of plasma glucose or a decrease of C-peptide occurs late in the course of rejection. When exocrine pancreatic function is preserved by anastomosis to the intestine, sampling of the pancreatic juice by intubation of the pancreatic duct can be used for measurement of pancreatic juice volume, enzymes, and bicarbonate, measurements that can be used for monitoring of graft function and early detection of rejection (C. G. Groth, personal communication). Likewise, measurements of urine amylase and bicarbonate can be used when the pancreatic graft is anastomosed to the urinary bladder. Imaging of pancreas transplants is possible by ultrasound and computed tomography (1). These methods are most valuable in the detection of peripancreatic fluid collections, and occasionally parenchymal abnormalities can be diagnosed.

Scintigraphy of the pancreatic graft with 75Se-labeled methionine (2) or 99mTc-labeled DTPA (3) has been successful in a few cases, but the methods have not become routine procedures. However, the vascular transit and volume may be evaluated by intravenous radionuclide angiography in the same way as that of a kidney graft (4), and a normal functioning pancreas graft should have an isotope histogram with a well-defined flow peak similar to that of the iliac artery, whereas loss of the peak may indicate dysfunction.

Angiography by selective catheterization of the iliac artery can visualize the graft and its vessels and diagnose vascular complications, but it is a highly invasive method that is not suitable for repeated investigations. However, by intravenous injection of contrast medium, the arterial as well as the...
MONITORING OF PANCREAS-GRRAFT PERFUSION

FIG. 1. A: radionuclide angiography with $^{99m}$Tc-pertechnetate visualizing kidney graft in left iliac fossa and pancreas graft in right fossa. B: well-defined flow peak on pancreas graft (upper curve) and ipsilateral iliac artery (lower curve).

venous phase may be visualized by digital subtraction angiography. By this technique, computerized electronic manipulation of the images permits subtraction of structures other than the opaque vascular structures and organs (e.g., the graft and its vessels). In addition, computerized electronic contrast enhancement makes it possible to increase the contrast sensitivity 10-20 times compared with conventional radiographic techniques.

From the beginning of our pancreas-transplant program, we investigated the value of radionuclide and digital subtraction angiography in the postoperative monitoring of graft function. Furthermore, we assessed whether the methods could be used for early diagnosis of complications.

MATERIALS AND METHODS

Five patients with end-stage diabetic nephropathy had combined pancreas-kidney transplantations. The graft vessels were anastomosed to the iliac vessels, and the exocrine function of the hemipancreas was preserved by end-to-end pancreaticojejunosotmy to a Roux-en-Y limb. A baby-feeding tube was placed in the pancreatic duct and brought out through a small jejunostomy. The tube was used for collection of pancreatic juice during the first 3 postoperative wk. Immunosuppressive therapy consisted of prednisone, azathioprine, and cyclosporin A. Rejection episodes were treated with 1 g methylprednisone the 1st day, followed by 0.5 g on each of the next 4 days.

Radionuclide angiography. Radionuclide angiography of the kidney and pancreas grafts was performed three times per week for the first 5 postoperative wk (7). A bolus of 370 MBq $^{99m}$Tc-pertechnetate was injected via a cubital vein. With a Siemens ZLC 37 scintillation camera with a high-resolution parallel-hole collimator coupled to a Scintiview computer, 120 frames for 1 min were obtained, and histograms from four regions of interest were processed. The regions were the kidney graft without underlying major vessels, the ipsilateral iliac artery, the pancreas graft without underlying major vessels, and the ipsilateral iliac artery. The iliac histograms were used to ascertain, by a well-defined peak, that a proper bolus injection had been given. Then it was assessed whether the pancreas and kidney histograms had well-defined, poorly defined, or absent flow peaks (Fig. 1).

Digital subtraction angiography. Digital subtraction angiography was performed one to two times during the first 5 postoperative wk and if perfusion evaluated by radionuclide angiography was absent. An intravenous bolus injection of 80 ml of a low-osmolar nonionic contrast medium (300 mg/ml iopamidol, Bracco, Milan) was given within 10 s. The contrast-medium passage through the iliac and graft vessels was recorded on a Philips digital subtraction unit with a 14-inch image intensifier with anterior-posterior exposures taken every second from 8 to 38 s after the start of injection (Fig. 2).

RESULTS

Four of the patients had one, two, one, and one rejection episode, respectively. All episodes were successfully treated, and in three patients, both organs are functioning well 14, 12, and 7 mo later, respectively. One patient with functioning grafts died 5 wk posttransplantation from a ruptured mycotic aneurysm at the arterial anastomosis to the pancreas graft.

Decrease of the graft perfusion, judged by disappearance of a previously well-defined flow peak, preceded otherwise detectable deterioration of the graft function in all five rejection episodes. Parallel decrease of perfusion in kidney and pancreas graft was observed. The flow peaks returned to normal after successful treatment of rejection.

Digital subtraction angiography could visualize the iliac and graft vessels in all patients, and no vascular thromboses were observed. The patient who died was not examined within the last week before rupture of the aneurysm.
DISCUSSION

During 10 yr, we have routinely monitored the perfusion of >500 kidney transplants by the described radionuclide method. From our first combined transplantation of pancreas and kidney, we observed that the method also visualized the pancreas graft. Because the method is rapid, easily repeatable, without complications, and the dose of radioactivity is small and harmless, we decided to test its use as a routine method for monitoring the pancreas-graft function and perfusion. Visualization of a normally perfused pancreas graft was easy, and in cases with the pancreas graft placed over the iliac artery, scanning with the γ-camera in an oblique position was successful. The best scintigrams were obtained on a γ-camera with a large field of view, but acceptable information was in some cases obtained at bedside with a mobile camera with a small field of view and two bolus injections, one for each graft.

Rejection treatment was based on the diagnosis of kidney rejection. Before or at that time, the perfusion of the pancreas graft had decreased. In two of the rejection episodes the baby-feeding tube was still in place in the pancreatic duct, and decreased pancreatic-juice volume and amylase concentrations were observed before rejection became evident. Based on the radionuclide angiography and monitoring of the exocrine secretion, rejection therapy was started before plasma glucose elevation occurred.

By digital subtraction angiography with intravenous injection of contrast medium, visualization of the kidney and pancreas grafts and the iliac and graft vessels was possible in all patients. The method is much less invasive than selective arterial angiography, and the small dose of a low-osmolar nonionic contrast medium seems not to damage or reduce kidney-graft function. Accordingly, the method can be used for investigations of the graft vessels if thrombosis or vascular complications are suspected in the early postoperative period.

REFERENCES