Diagnosis of Segmental Necrosis in a Pancreas Transplant by Thallium-201 Perfusion Scintigraphy

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Thallium-201 was used to image a patient with a pancreatic transplant. Incomplete visualization of the graft on the ^{201}Tl scan, compared to CT, led to the diagnosis of segmental necrosis of the tail of the graft. Due to the low background and favorable target-to-non-target ratio, ^{201}Tl pancreas scintigraphy may be useful in the follow-up of pancreatic transplants.

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The initial flow and blood-pool phase of the ^{99m}Tc-DTPA renal study has been shown to be a sensitive though nonspecific indicator of flow status of the neighboring pancreatic transplant (*1,2*). We present a case where ^{201}Tl was used as a pancreatic imaging agent with marked improvement in organ visualization.

CASE REPORT

A 28-yr-old male with longstanding insulin-dependent diabetes mellitus underwent a simultaneous cadaveric kidney/pancreas transplantation. The kidney was implanted in the left iliac fossa and the pancreas, measuring approximately 20 cm, on the right by a pancreaticoduodenocystostomy. As the donor's celiac truncus had been used to harvest the liver, the splenic artery, supplying the pancreas, was grafted to the donor's superior mesenteric artery (*3*) and then to the external iliac artery of the recipient.

A routine immunosuppressive protocol was started (*1*). The patient was normoglycemic, requiring only insulin coverage for his parenteral nutrition. Creatine was 2.1 mg/ml off dialysis. On the sixth postoperative day, the white blood cell count had risen to 19.600/mm^3, glucose to 289 mg/ml, and creatinine to 2.6 mg/ml. Ultrasound (US) showed an enlarged pancreatic head and body. The tail was not visualized due to overlying gas. Doppler US showed possible absent flow in the splenic vein. On computerized tomography (CT) without contrast, inflammatory changes surrounding the pancreas and two high-density tubular structures within the pancreatic tail suggestive of thrombosed vessels (Fig. 1) were noted.

A ^{99m}Tc-DTPA study was performed with a 7500 Siemens Orbiter peaked at 140 keV with a 15% window. Upon intravenous injection of 15 mCi, 2-sec frames were obtained for 1 min followed by a 600,000 count blood-pool image and sequential 5-min images for the same time (Fig. 2). There was good perfusion of the enlarged head and body. The tail could not be assessed with certainty due to high background activity.

The following day, a ^{201}Tl study was obtained with the same camera peaked at 81 and 167 keV, with windows of 30% and 20%, respectively. After intravenous injection of 2 mCi ^{201}Tl, sequential 5-min images were obtained up to 30 min (Fig. 3). The head and body showed good uptake of the radioisotope from the first image on and measured 5 to 6 cm each using a lead marker as reference. Background decreased markedly after 5 min. The tail, which on CT extended to the right flank, remained photopenic, indicating absent perfusion of that segment.

The patient underwent surgery. A 9-cm necrotic tail was resected. On pathologic examination, extensive fatty necrosis and vascular thrombosis of the small vessels was seen. Biopsy of the kidney showed mild acute tubular necrosis. A peripancreatic abscess was percutaneously drained 2 wk later. The patient has remained euglycemic.

DISCUSSION

Most complications of pancreatic transplantation in the initial postoperative period are surgical with intra-abdominal infection and vascular thrombosis as leading causes, followed by pancreatitis, peripancreatic inflammatory collections, and other less frequent problems. Rejection accounts for the other failures and is usually more important in later stages (*1,4*).

Since percutaneous biopsy has a high rate of complications, the clinician relies on a combination of noninvasive tests. Glucose, C-peptide, urine amylase, and creatinine to monitor associated kidney rejection, are helpful though each have there own limitations.

Currently, perfusion of the transplant is most often monitored by Doppler US and with ^{99m}Tc-DTPA flow and blood-pool imaging (*5–6*). The latter has a high sensitivity,

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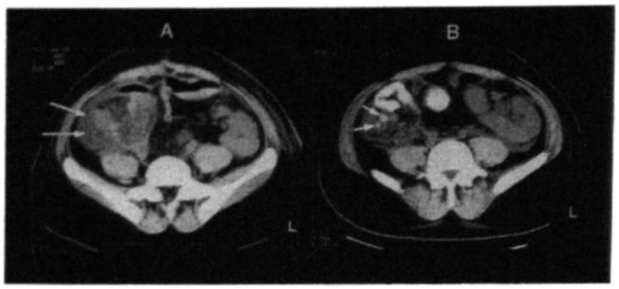

FIGURE 1. CT section through the head (A) and the tail (B) of the transplant showing edema of the head (arrows) and thrombosed vessels in the tail (short arrows).

but lower specificity (*2*). Technetium-99m-DTPA scintigraphy alone or in combination with urine amylase and serum creatinine has also been used successfully to monitor early rejection (*7,8*). Caution remains as there are several unexplained false-positive and false-negative studies (*6*), and confirmation by arteriography in the case of absent perfusion has been suggested (*1*). Anatomic delineation of surgical complications is usually better with US or CT (*9*). Magnetic resonance imaging has shown promise both for surgical complications and for rejection. It is hampered, however, by false-positives for the latter in the postoperative period (*10*).

Since its introduction as a myocardial imaging agent (*8*), ^{201}Tl has been useful in several other areas, e.g., in parathyroid and metastatic tumor imaging and to assess muscle perfusion, based on its high peripheral extraction.

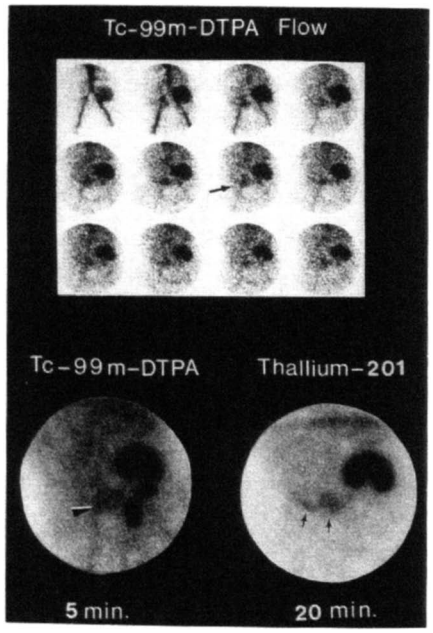

FIGURE 2. Technetium-99m-DTPA flow and blood-pool images show adequate flow (arrow) and blood-pool activity in the head (arrow heads). The tail is not clearly visualized. A corresponding ^{201}Tl image shows good uptake in the head only (short arrows). Note the low background.

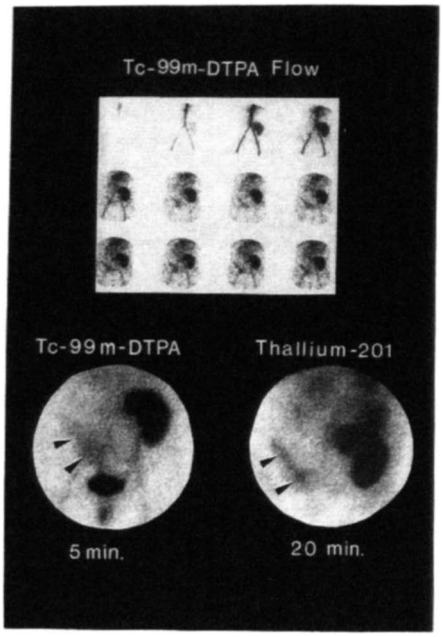

FIGURE 3. Technetium-99m-DTPA flow and blood-pool images and corresponding ^{201}Tl study of a normally functioning transplant (arrow heads). Note the better visualization of the pancreas and low background on ^{201}Tl images.

We found little information on its kinetics in the pancreas (*8,11*), perhaps because it is included in the small intestine fraction in most biodistribution studies. In view of a blood clearance half-time of 5.1 min (*8*), a 5-min image performed 25–30 min postinjection should give excellent results since background caused by blood-pool activity will be low. While assessment of ^{99m}Tc-DTPA images is hampered, especially in the postoperative period as in our case, by edema and inflammation of surrounding tissues, high contrast can be attained with ^{201}Tl in this situation. We have also imaged four other patients with ^{201}Tl who were at least 6 mo postoperative after an uncomplicated transplantation and who were euglycemic, all in the non-fasting state. Figure 3 shows one such study with good visualization of the graft and very low background. Although the intestinal tract is outlined, it usually does not overlie the pancreas in the supine position and has not interfered with visualization of the graft.

Because ^{201}Tl uptake is also dependent on cellular viability, it might be helpful in the early detection of rejection. The newer brain radiopharmaceuticals are now being used to image the native pancreas (*12*), and the newer cardiac agents may give good results as well. Further studies should include comparison of these agents in the case of transplants.

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AUGUST 1976

Interpolative Background Subtraction

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In a scintigraphic image, body or nontarget background is generally handled by subtraction across the board (threshold setting) or by delinearization of the display response (contrast enhancement). For some situations, we have found it better to define background as a fixed fraction of the image area. In come cases, however, a more precise quantitation of the background is helpful. Schelbert et al. and Van Dyck et al. assumed that the count rate originating in the region adjacent to the target organ was representative of the background component of the target count rate. In effect, they used an average background, but the main thrust of their method was to take the background sample as a ring around the target.

We surmised that if the changes in regional background are relatively monotone, the background could be better approximated by linear interpolations than by simple averaging.

Two millicuries of ^{201}Tl-chloride are injected intravenously with the patient at rest or exercising to angina or ST-segment changes on electrocardiography. Data are collected between 5 and 30 min in the anterior, left anterior oblique, and the left lateral projections. The scintillation cameras are interfaced with the dedicated digital computer and the scintigrams are digitized and stored as 64x64 data arrays. Within this array, a rectangular area surrounding the target is defined. All data points outside of this area are set equal to zero. From each data point within the area, the computer subtracts a background value equal to the value of the two intersecting linear interpolations between the values of the point of interest.

For variable but monotone backgrounds, theoretical considerations show that an interpolated background subtraction is preferable to an averaged background subtraction. This is easily illustrated with phantoms having the appropriate characteristics. In the clinical application of myocardial scintigraphy with thallium, the procedure was helpful in the interpretation of data. ■

AUGUST 1961

Intragastric Beta Irradiation with Ru-Rh106 in Human Subjects: Results with Single Doses

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Beginning in 1909, X-ray therapy for peptic ulcer has been the subject of much interest. In 1935, Kruglikowa et al. remarked that they were aware of over 200 papers on this subject. Enthusiastic remarks on results in over 800 cases were made by Hedfield in 1948, but his data were lost during the war. In 1957, Palmer, Kirsner and their associates summarized the results from 723 cases representing over 20 years of experience, clearly establishing that X-ray therapy given according to modern principles was a useful adjunct to the medical management of duodenal ulcer and would significantly reduce the recurrence rate. Recently there have been promising results with supervoltage X-ray in patients with gastrojejeunal ulcer and with gamma rays of ^{60}Co.

The application of intragastric techniques with a beta-emitting source would appear to obviate many of the objections to radiation therapy, if adequate tissue penetration of the beta particles would limit the amount of radiation delivered to other organs. This approach has been studied in the gastric fistula of dogs by a number of investigators.

It was our intent in this study to learn first the effects of single doses on gastric acid secretion and on morphology of the gastric mucosa.

Six patients were treated. The instrument (a brass cylinder, 6 mm in diameter and 18 mm long, electroplated with 100 mCi of Ru-Rh106, coated with a very thin plating of silver, affixed to a slide wire, and encased in a steel shield) was passed by mouth using premedication as for gastroscopy. The balloon was inflated with air, giving a sphere of approximately 5 cm in diameter. All patients were observed and gastric analyses were performed at frequent intervals up to 22 mo following treatment. Basal secretions were collected for 1 hr, and then for an additional 90 min following subcutaneous injection of histamine.

Dosage estimated with an especially designed extrapolation chamber ranged from 200 to 1000 rep at the surface of the mucosas. Dosage rates varied from 8.4 to 5 rep/min. In all but one case, dosage rates of 450 rep or larger resulted in abolition of or substantial decrease in basal acid secretion. Gross and microscopic anatomic changes were observed even with the smallest doses (200 rep). These alterations became evident more quickly and were more severe as dosage increased. With doses of 600 rep and larger, chronic ulcers of the lesser curvature were observed. ■