

Radionuclides in the Postoperative Management of Orthotopic Human Organ Transplantation¹

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FOR SEVERAL years an active program in human organ transplantation has been conducted at our institution (1-3), and since March 1962, 214 patients have received renal transplants. Two thirds of these transplanted kidneys are still functioning and most of these patients are living nearly normal lives. In addition, limited success has been achieved in liver transplantation (4-6). Of 14 recipients of orthotopic cadaveric human liver transplants, 5 are living. Several spleen transplants have also been performed (7-9); although these patients survived, the procedures were not beneficial.

The transplantation team has found the ¹³¹I-Hippuran renogram and ¹⁹⁷Hg-chlormerodrin renal scan helpful in many cases of renal transplantation. The ^{99m}Tc-sulfide liver scan has proved valuable in the postoperative management of patients subjected to liver transplantation, and in two of the spleen transplant cases the radioisotope scan offered a means of visualizing the transplanted organ.

RENAL TRANSPLANTATION

In a transplanted kidney which is functioning well, a nearly normal renogram pattern can be recorded following the intravenous injection of 50 μ Ci of ¹³¹I-labeled Hippuran. The probe is positioned anteriorly over the kidney which can be located by palpation in the pelvis. The tail end of the recorded curve will be somewhat elevated compared to the usual renogram because of the proximity of the bladder which will contain a relatively large amount of the radioactivity injected. In several patients acute oliguria or anuria has developed at varying times in the postoper-

ative course. Clinically, it may be difficult to tell whether this is caused by renal arterial insufficiency, rejection of the kidney, or ureteral obstruction. In all three situations, the renogram becomes abnormal. In severe rejection or in cases where the renal artery is kinked, the renogram will be low and almost flat. In cases of milder rejection, the renogram shows an obstructive pattern with a normal early phase which continues to ascend without development of the usual excretion pattern. This same pattern is seen in ureteral obstruction.

The renogram is usually preceded by the performance of a ¹⁹⁷Hg-chlormerodrin renal scan. Two hundred microcuries of mercury-197 are injected intravenously, and one hour later the scan is performed. In a normally functioning transplanted kidney, a sharp outline is recorded. In cases of renal artery insufficiency and also in cases of severe rejection, the kidney becomes less and less well visualized with more and more of the mercury being taken up in the liver and spleen. Serial tests are helpful in assessing the progress of some of these patients.

SPLEEN TRANSPLANTATION

Two patients with spleen transplants have been studied. One boy who was suffering from agammaglobulinemia and repeated severe disabling pulmonary infections received a transplant of his mother's spleen in an attempt to colonize his body with immunologically productive lymphocytes from the mother. The surgical procedure was technically successful, but there was no real evidence of an increase in immune globulins of maternal origin. Even-

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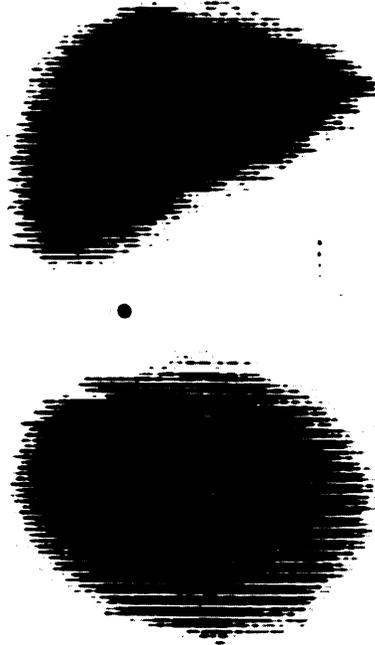


Fig. 1. Anteroposterior and right lateral ^{99m}Tc -sulfide liver scans in a patient ten months after orthotopic cadaveric liver transplantation, showing normal function and configuration.

tually, immunosuppression was stopped and the transplant involuted. The second case was one in which a father's spleen was transplanted into his son, who was suffering from hemophilia. Four days later, the transplanted spleen ruptured, necessitating its removal. In both cases, the radioisotope scan permitted excellent visualization of the transplanted organ. In the first, the spleen gradually disappeared from the scan as it became atrophic. In the second case, the splenic hemorrhage was not visualized since it was extracapsular and did not indent the spleen.

LIVER TRANSPLANTATION

In caring for patients after orthotopic hepatic transplantation, it became evident that crucial and incisive information on organ size and function could be obtained with serial liver scans. Of even greater importance, localized intrahepatic lesions such as abscesses and infarcts could be accurately identified and followed (4, 5, 10).

Only with the recent introduction of

short-lived isotopes for liver scanning has it been possible to perform frequent serial scans safely. In our patients we have used ^{99m}Tc -sulfide particles. The technic of preparation was slightly modified from that described by Stern and Patton and their associates (11, 12). An intravenous dose of 800 μCi per scan is used in children and 2 to 3 mCi in adults. This gives a radiation dose to the liver of 0.8 rads per scan.

Scanning was done with 3- and 5-inch crystal rectilinear scanners in dogs and patients, respectively. In children and dogs, a high-energy, fine-focus collimator was used at a speed of 150 cm per minute and a line spacing of 0.2 inch. Immobility of the subject for approximately twenty minutes is required for a technically satisfactory scan with the 5-inch crystal scanner, but more recently we have employed a 10-crystal rectilinear scanner in patients, which requires less than two minutes per view.

The central role which this diagnostic technic has come to occupy in the post-transplantation period of such patients has prompted us to investigate the various factors that might influence liver scans. Dogs were subjected to common duct or hepatic artery ligation, portal-to-systemic venous diversion, and orthotopic homotransplantation to treated or untreated recipients. These animal studies are reported in detail elsewhere (10). In essence our results showed that frequent serial injections of ^{99m}Tc sulfide caused no detectable deleterious effect in dogs. We also found that bile duct ligation and hepatic artery ligation resulted in no acute change in the liver scan except for the appearance of a large antero-centro defect due to distension of the gallbladder in the former. Undoubtedly, if progressive biliary cirrhosis had developed in these animals, other changes would have been noted. Eck fistulas were produced in 3 dogs. In these the scans showed a definite and progressive diminution in liver size and the development of areas of diminished radioisotope uptake, conforming to the hepatic atrophy noted at autopsy. Dogs treated with orthotopic

hepatic transplantation and subjected to serial scanning showed changes similar to those noted in the patients described below.

In patients who are doing well after orthotopic hepatic transplantation, serial ^{99m}Tc -sulfide scans have been obtained about once weekly for four to six weeks



Fig. 2. Anteroposterior and right lateral ^{99m}Tc -sulfide liver scan in a patient two months after orthotopic cadaveric liver transplantation, clearly demonstrating infarction and abscess formation in the right lobe.

and then less and less often as the patient's condition improved, but at least once a month in all patients. No detectable deleterious effect or morbidity has been associated with these repeated scans. One little girl received 25 scans during the more than thirteen months of her life following liver transplantation. She finally succumbed to widespread metastasis from the hepatoma present preoperatively. At the time of autopsy, no changes attributable to radiation or the technetium sulfide could be demonstrated (Fig. 1). In several of the patients who received hepatic transplants in the latter half of 1967 infarction developed, complicated by abscess formation in the right lobe of the liver. Technical revisions in the surgical procedure seem to have eliminated this complication in later cases (5). In these patients the liver scan clearly demarcated these lesions, assisting the institution of appropriate surgical drainage (Fig. 2). Rejection has devel-



Fig. 3. Anteroposterior ^{99m}Tc -sulfide liver scan after orthotopic cadaveric liver transplantation, demonstrating a swollen liver with a decrease in hepatic concentration and an increase in extrahepatic deposition of isotope in the reticuloendothelial cells of the bone marrow and lungs.

oped in other patients. Their scans demonstrate swelling of the liver as well as decreased hepatic concentration of isotope and increased extrahepatic deposition in the reticuloendothelial cells of the bone marrow and lungs (Fig. 3). These changes were identical to the pattern seen in cirrhosis except for the absence of spleens, most of which had been removed at the time of surgery. In several instances, this picture reverted completely to normal as the rejection process was brought under control.

There developed in 2 patients increasing jaundice, serum chemical abnormalities, and deteriorating scans. Clinically, it was not possible to tell whether they were suffering from intrahepatic or extrahepatic biliary obstruction. After intravenous injection of ^{131}I rose bengal, serial scans were performed over a forty-eight-hour period (13), and serial counts were taken over the head, liver, heart, and lower abdomen (14). The scans revealed no excretion of rose bengal into the intestinal tract, and blood-to-liver ratios were consistent with intrahepatic obstruction. Both patients proved eventually to be suffering from rejection, and liver biopsy in one of them disclosed dilated biliary canaliculi and other

changes consistent with an intrahepatic type of obstruction.

SUMMARY

Nuclear medicine can play an important role in the postoperative management of patients subjected to orthotopic human organ transplantation. Changes in the radioisotope renogram and renal scan aid in evaluation of the function of transplanted kidneys but have proved to be of limited value in assessing the etiology of impaired function. In transplanted livers, infarctions and abscesses can be demarcated, and the development of rejection demonstrated by the ^{99m}Tc -sulfide scan.

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