EVALUATION OF PORTAL CIRCULATION BY THE SCINTILLATION CAMERA

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Techniques using radionuclides in the examination of portal circulation have previously been used for qualitative or quantitative evaluation of the occurrence of portal-systemic shunts (*1–10*) even though they do not provide any anatomical information about pathological changes in portal circulation. In the present study, such information has been obtained by adopting sequential scintiphotography of the portal area (using a scintillation camera) after intrasplenic injection of radiopertechnetate.

METHOD

To determine the optimum site of percutaneous spleen puncture, splenic scanning was carried out one day before examination in lateral projection after reinjection of autologous erythrocytes labeled with ^{99m}Tc and damaged by heating.

Radionuclide splenoportography was performed with the patient supine. The scintillation camera (Nuclear-Chicago Pho/Gamma III) was positioned so that the spleen, the liver, the heart, and a significant portion of the lungs were located within the field of view of the detector head. To cover the entire area under study, it was necessary to use a diverging collimator. Five to 10 mCi $^{99m}TcO_4^-$ and 200–300 μCi ^{131}I-macroaggregated albumin (^{131}I-MAA) were injected percutaneously into the spleen. The total volume did not exceed 2.5 ml. The passage of the radiopertechnetate bolus through portal circulation was recorded for 1 min on a video tape. The window of the pulse-height analyzer was set on the 364-keV peak of ^{131}I and the data were stored in the memory of the Nuclear-Chicago multichannel analyzer over a period of 5 min. Then the distribution of ^{131}I-MAA activity in the investigated area was displayed and evaluated on the screen of its oscilloscope. According to Ueda and associates (*10*), the deposition of ^{131}I-MAA in the lungs is a highly sensitive indicator of portal-systemic shunts. The clinical usefulness of this method was also confirmed by other authors (*11–13*).

The record of the passage of the ^{99m}Tc bolus was played back on the persistence scope and selected time intervals were replayed in the memory of the multichannel analyzer for detailed evaluation. On the screen of the persistence scope, three areas of interest were selected which corresponded to the splenic vein, the right liver lobe, and the precordium. The changes of activity in the selected areas were stored as histograms in the multichannel analyzer by replaying from a magnetic video tape recorder. The preset time of the histogram module was programmed to 200 msec. To facilitate the reading of the circulation times in the selected areas, the three curves were also processed as digital data by the printer.

RESULTS

Figure 1 shows a radionuclide splenoportogram in one of the control subjects; the portal bed and the liver are filled in the first seconds after injection. The pictures taken 17 and 23 sec after injection show a gradual flow of the ^{99m}Tc radioactivity from the liver into the systemic circulation. The central picture at the bottom has been taken from the scope of the multichannel analyzer and corresponds to the time interval of 1–11 sec after injection. At the bottom to the right, the distribution of ^{131}I-MAA after splenic injection is depicted. No radioactivity could be found in the lungs.

Figure 2A shows radioactivity tracings (histograms) in the areas of the splenic vein, liver, and precordium. The time interval required for the passage of the bolus from the splenic vein to the pre-

Received Mar. 8, 1972; original accepted Apr. 27, 1972.

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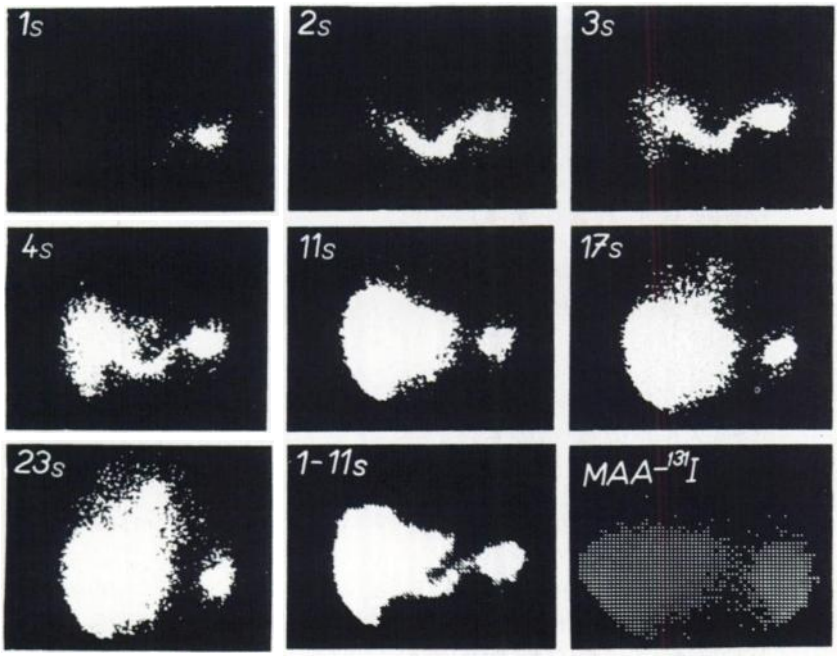

FIG. 1. Radionuclide splenoportogram of control subject after splenic injection of $^{99m}TcO_4^-$ and ^{131}I-MAA.

cordium area was 12 sec (in control persons, 8–15.6 sec; in patients with hepatopathy without portal-systemic shunts, 8–17.8 sec; and in portal hypertension with collateral circulation, 2–7.2 sec).

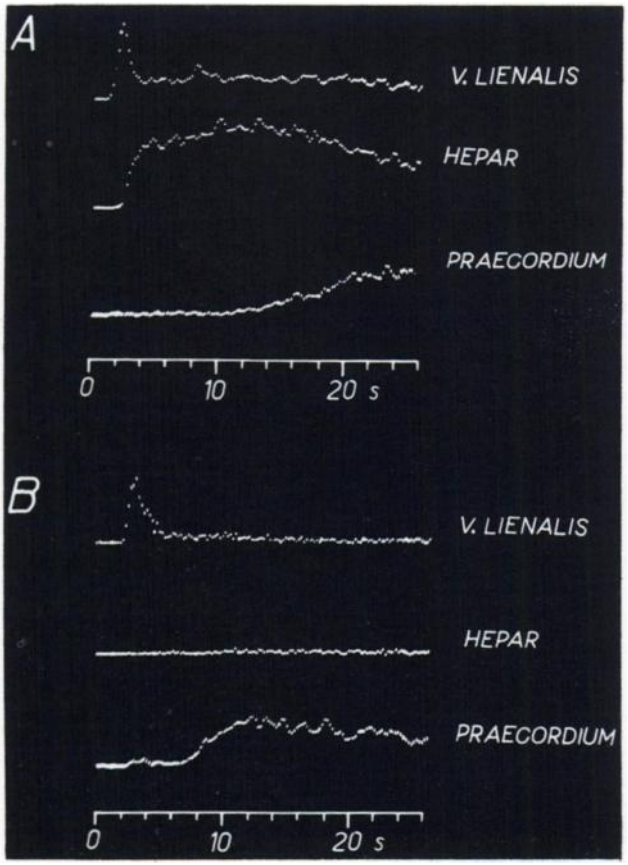

FIG. 2. Transit time activity histograms representing count changes within selected areas over splenic vein, liver, and precordium during first 20 sec following splenic injection of $^{99m}TcO_4^-$ in control subject, A; and in patient with tumorous thrombosis of portal vein, B.

Figure 3 shows a radionuclide splenoportogram obtained from a patient with liver cirrhosis and rapidly developing ascites. During the first seconds after splenic injection, only the splenic vein and the distal part of the portal vein are being filled and then, beginning with the fourth second, the collateral flow through esophageal varices can be seen. The ^{131}I-MAA scan reveals a massive deposition of radioactivity in the lungs and none in the liver.

In Fig. 2B, the histograms show that in the course of examination the radioactivity in the liver does not rise. The early appearance of the tracer in the precordial area (the time interval required for the passage of the bolus from the splenic vein was 4.5 sec) is typical for hemodynamically significant shunts. These findings clearly show the presence of portal vein occlusion with an abundantly developed collateral circulation. Our conclusions were fully confirmed by autopsy which revealed a hepatoma associated with liver cirrhosis and tumorous thrombosis of the portal vein.

The procedure under discussion was used in 61 persons, i.e., 14 control subjects, 30 patients with liver cirrhosis, four with chronic hepatitis, two with metastases of a malignant tumor of extrahepatic primary localization, one with constrictive pericarditis and hepatomegaly, one with alcoholic hepatopathy, and one with noncirrhotic liver fibrosis. There were five more patients with prehepatic portal hypertension and three with mesocaval anastomosis.

In 26 patients, we observed portal-systemic shunts

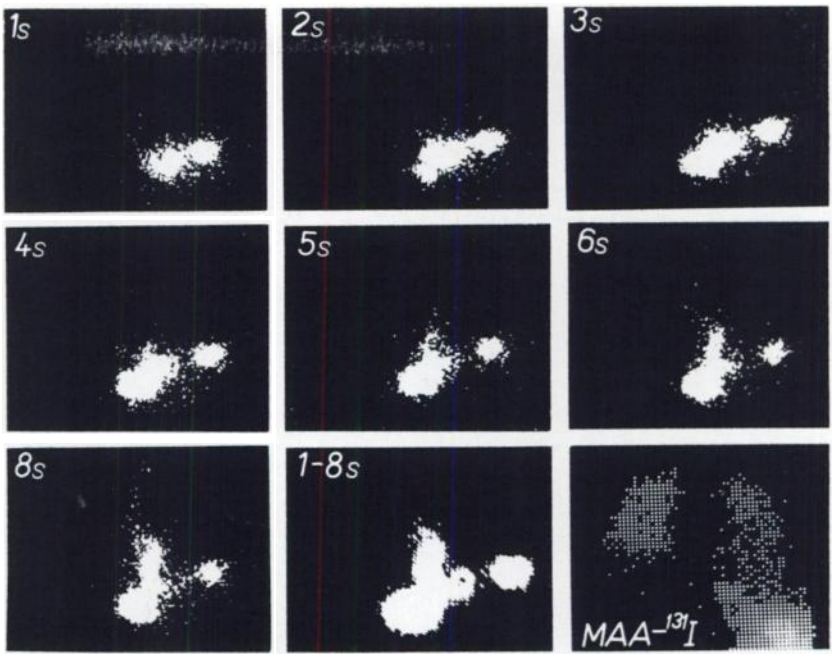

FIG. 3. Radionuclide splenoportogram of patient with tumorous thrombosis of portal vein after splenic injection of $^{99m}TcO_4^-$ and ^{131}I-MAA.

of various kinds and localizations. The results obtained were in accord with the clinical and biochemical findings, the x-ray examination of the esophagus, contrast splenoportography, or mesenterial angiography. In five patients, portal or splenic vein occlusions were detected which later on could be confirmed by contrast examination or autopsy. Three patients were examined after mesocaval anastomosis. In all of them, patency of the shunt was visible in the radionuclide splenoportograms which was in good accord with the condition of the patients.

CONCLUSIONS

The resolution of the radionuclide imaging is less than that of contrast x-ray examination. Consequently, the technique described is not meant to replace contrast angiography of the portal bed. But still, in our opinion, it is a considerable contribution to the diagnosis of pathological changes in portal circulation. The small volume of the injected material and a very thin needle used for splenic injection of the tracer reduce the patient's trauma to a minimum; the danger of bleeding or rupture of the spleen is negligible.

We have so far performed more than 300 radionuclide splenoportographies using various techniques without any complications. The method described is also applicable to children and severely ill patients.

The technique combines the advantage of a morphological and a functional examination since it permits the evaluation of the length, course, and patency of the portal vein. It reveals the presence of collateral circulation, its extension and localization, and intrahepatic shunts. It offers useful data concerning the velocity of the passage of the radioactive bolus through the areas of the spleen, liver, and chest. Combined with the evaluation of the ^{131}I-MAA distribution after intrasplenic injection, it gives information about functional portal blood flow through the liver. In correlation with other results, these data help to select the most suitable surgical shunt. After surgery which leaves the spleen in situ, radionuclide splenoportography can reveal the patency of shunts. Furthermore, it might be a reliable technique for detecting suspected portal vein occlusions.

SUMMARY

The authors describe a new technique of radionuclide splenoportography, i.e., injection of 5–10 mCi of $^{99m}TcO_4^-$ into the spleen and followup of the passage of the radioactive bolus through the portal vein bed by means of a scintillation camera combined with a video tape recorder and a multichannel analyzer. Simultaneously, ^{131}I-MAA is injected into the spleen. The oscilloscope of the analyzer serves to assess the ^{131}I-MAA deposition in the lungs which indicates the presence of portal-systemic shunts. The experiences in 61 subjects show that the method can be used for the detection of collateral circulation and its extension and localization. It is also useful for the appraisal of the functional flow of portal blood through the liver, for the diagnosis of prehepatic portal hypertension, and for the evaluation of the patency of the surgically introduced shunt.

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