# EVALUATION OF SPLENIC FUNCTION USING $^{197}$Hg-MERCURIHYDROXYPROPANE

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Radioisotopic evaluation of the functional capacity of the spleen to sequester red cells was made possible when $^{51}$Cr was introduced in 1950 (*1*). The clinical usefulness and validity of this type of study has been well documented (*2–5*). A major disadvantage of sequestration studies with $^{51}$Cr is the 7–14 days required to complete them.

A technique which allows the spleen to be scanned shortly after the intravenous injection of red cells damaged by 1-bromomercuri-2-hydroxypropane (MHP) was introduced by Wagner and associates (*6*). Either $^{203}$Hg or $^{197}$Hg can be used as the radioactive label on the MHP. This material binds to red blood cells by reacting with protein sulfhydryl groups and damages the red-cell membrane sufficiently to allow sequestration by the spleen. The rate of splenic sequestration of MHP-labeled red cells in normal subjects is relatively rapid with very little radioactivity appearing in the liver (*7*).

It appeared reasonable to assume that the rate and magnitude of uptake of MHP-labeled red cells by the spleen in normal subjects should be different than in patients with hypersplenism. Therefore the study reported here was undertaken in our clinic.

## MATERIALS AND METHODS

Fifty-six patients were included in this study. After all data were evaluated, 29 patients were thought to show no abnormality in splenic function despite the fact that 10 did have splenomegaly. The other 17 were considered to show evidence of excessive loss of red cells. Thirteen patients in this latter group also had enlarged spleens. These patients were also evaluated for hypersplenism in a variety of other ways. These included sequestration of $^{51}$Cr-labeled red cells and Coomb's test, as well as the usual tests for determining loss of formed elements in the blood (anemia, reticulocytosis, jaundice and pancytopenia).

The majority of the function studies and scans were performed with $^{197}$Hg-MHP (E. R. Squibb & Sons). In a few instances, when $^{197}$Hg-MHP was not available, the $^{203}$Hg preparation was used. Three-hundred microcuries of $^{197}$Hg were used in the average adult with an equivalent per kilogram dose for children. The dose of the $^{203}$Hg-MHP was 100 $\mu$Ci with these latter studies limited to adult patients.

Two milligrams of MHP per milliliter of blood has been established as the upper limit in concentration for these studies (*7*). Larger doses tend to alter the red cell so that liver clearance is favored. Doses of MHP between 0.1 and 0.2 mg/ml of blood were used in our studies. The radiopharmaceutical was mixed with 6–10 ml of the patient's blood, incubated for approximately 5 sec and then reinjected through the same venipuncture.

Before the injection of the labeled red cells, scintillation probes were placed over the spleen and liver of the supine patient. Recordings were then made of the radioactivity in these organs for the first hour after the injection. Care was taken to place the probes as close to the major mass of spleen and liver tissue as possible. After the 1-hr uptake test was completed, the spleen was scanned using a conventional rectilinear scanner.

Fifteen patients in our series were also studied by the $^{51}$Cr red-cell sequestration technique (*4*). The MHP study was usually done immediately after the $^{51}$Cr procedure. The two studies were reviewed independently by different observers.

## RESULTS

Spleen scans performed on all of our patients permitted them to be divided into two groups, those with normal-sized spleens (using dimensions of 6 $\times$ 13 cm as upper limits of normal) and those exhibiting splenomegaly. Patients were further subdivided on a clinical basis as to normal or hyperfunction. Figure 1 shows the pattern observed in normal subjects. This pattern is characterized by an initial rapid uptake of radioactivity in the liver reaching a plateau within minutes after the injection of the MHP-labeled red cells. The splenic uptake of radioactivity rose

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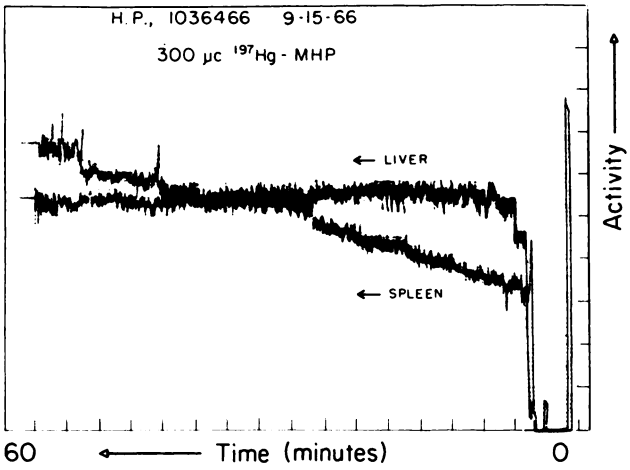


**FIG. 1.** Uptake of MHP-labeled red cells in normal spleen. Note that splenic radioactivity surpasses that in liver during first hour following MHP administration.

more slowly and usually exceeded the activity in the liver within ½ hr after injection. The splenic radioactivity usually reached a plateau by the end of the 1-hr recording period. In a few instances the splenic plateau occurred rather early in the recording period so that the splenic tracing remained slightly below that of the liver. Tracings obtained from patients in our group with splenomegaly but with no evidence of splenic hyperfunction, were found to be similar to those shown in Fig. 1.

Figure 2 gives typical tracings of liver and spleen uptake of the MHP-labeled red cells as well as a typical scan of the spleen obtained from a patient in the group with splenomegaly and clinical evidence of hypersplenism. The rate of uptake over the spleen was initially very rapid and was either always above or exceeded liver radioactivity within a few minutes after administration of the labeled red cells. The curve of splenic radioactivity continued to rise steadily throughout the 1-hr test period.

The uptake curves obtained in patients with hypersplenism but with normal-sized spleens were quite similar to that shown in Fig. 2. There was always a rapid initial rise in splenic radioactivity. However, the remainder of the curve tended to be slightly flatter than that seen in Fig. 2.

Table 1 compares data obtained on splenic sequestration of red cells in 15 of our patients as measured using both $^{51}$Cr and MHP-labeled red cells. The ultimate clinical judgment as to the splenic functional status is also shown. Excellent correlation of the results from the two studies was found in 11 of the patients, all of whom were thought clinically to exhibit hypersplenism. Of the four other patients in this series, three were thought clinically

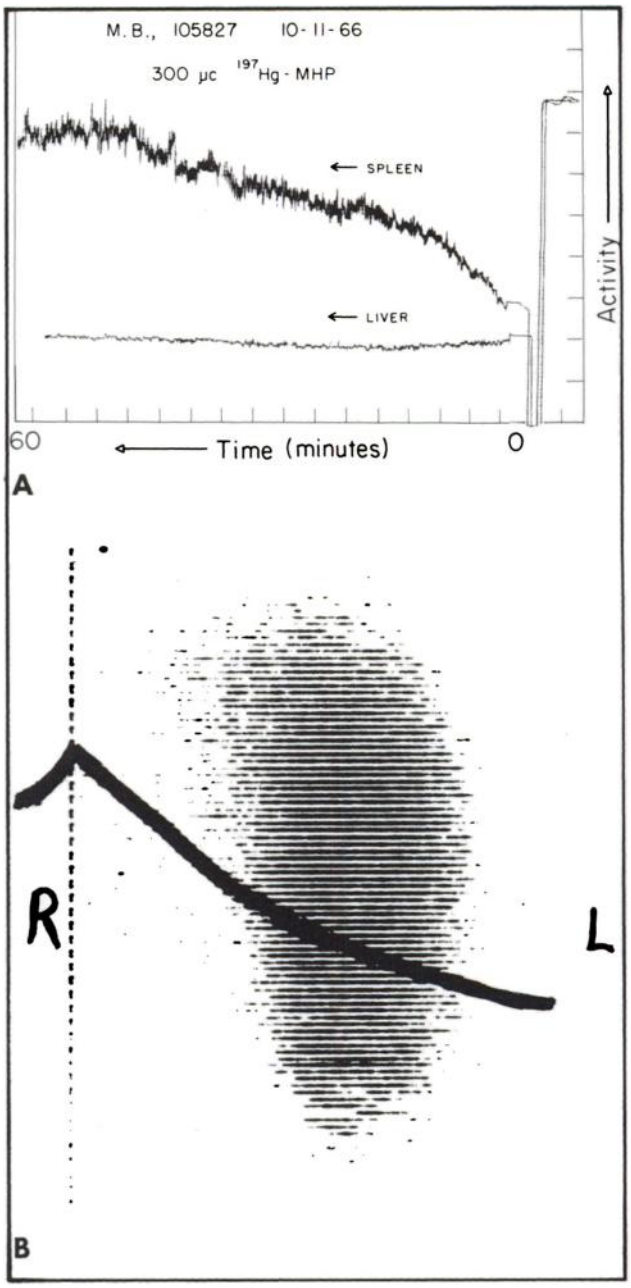


**FIG. 2.** Spleen uptake curve and scan of patient with verified hypersplenism. Note rather steep rise of radioactivity over spleen which is always greater than that in liver. Scan shows good uptake of MHP-labeled red cells in an enlarged spleen.

to have mild hypersplenism. In two of these the $^{51}$Cr data gave clear-cut evidence of excessive red-cell sequestration whereas the MHP studies were considered to be normal (TF, HW). The final two patients were difficult to evaluate and equivocal results of $^{51}$Cr studies were obtained on both. One (EK) was thought to show mild hypersplenism with supporting data from the MHP study. The other (KP) was thought to be normal clinically and showed normal MHP data.

**TABLE 1. CORRELATION OF DATA ON SPLENIC SEQUESTRATION OF ERYTHROCYTES USING $^{197}$Hg-MHP AND $^{51}$Cr-LABELED CELLS**

| Patient | Spleen size | MHP function | $^{51}$Cr sequestration | Overall clinical evaluation |
|---|---|---|---|---|
| BA | Normal | + | + | + |
| MB | Large | + | + | + |
| OB | Normal | + | + | + |
| TF | Normal | O | + | + |
| EKar | Large | O | O | O |
| RK | Large | + | + | + |
| EK | Large | + | ± | ± |
| FL | Large | + | + | + |
| EM | Large | + | + | + |
| RM | Large | O | O | O |
| RN | Normal | O | O | O |
| WN | Normal | O | O | O |
| KP | Normal | O | ± | O |
| HW | Large | O | + | ± |
| GW | Large | + | + | + |

+ = Hypersplenism
± = Equivocal
O = Normal

## DISCUSSION

The splenic curves obtained with continuous monitoring following the intravenous administration of MHP-labeled red cells appear to follow definite and reproducible patterns. The data presented here suggest that the capacity of the spleen to sequester red cells as well as its appearance by scan can readily be obtained by using MHP. Comparison of these data with those obtained using $^{51}$Cr-labeled red cells show reasonably good correlation with the overall clinical evaluation of the patients included in our series. In 11 of the 15 patients studied by both techniques the status of splenic sequestration of erythrocytes appeared to be accurately determined by both methods. In the four remaining patient studies, there were three with clinical evidence of hypersplenism. In only one of these did the MHP test suggest this entity. The one remaining patient was thought to be normal clinically and had a normal MHP test.

No attempt has been made in this study to obtain quantitative data on splenic function, i.e. function per unit mass of spleen. This would be desirable for a more exact evaluation of this technique for studying splenic function. To accomplish this, several factors must be carefully controlled. First of all, the procedure itself must be strictly standardized as to the number of milligrams of MHP per milliliter of patient's blood as well as to total quantity of radioactivity. Secondly, splenic size must also be accurately ascertained. This information may be obtained from spleen scans in multiple projections. Other factors which must be considered include the patient's weight, girth and the presence of overlying adipose tissue or ascitic fluid.

## ACKNOWLEDGMENT

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