DIAGNOSTIC SIGNIFICANCE OF THE RELATIVE UPTAKE OF LIVER COMPARED WITH SPLEEN IN ^{99m}Tc-SULFUR COLLOID SCINTIPHOTOGRAPHY

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Rappaport has recently published a detailed review of pathologic states of the splenic pulp (*1*). A prominent aspect of the pathologic spleen in most of the diseases referred to in his paper is a *widening* of the pulp cords. This pathologic feature suggested to us that the appearance of the spleen on the colloidal scan might be affected in such a way that the *relative* uptake of liver, spleen, and bone marrow could be a useful diagnostic adjunct.

Several authors (*2*) have reported their findings in spleen and liver scanning, and bone marrow delineation in conditions such as cirrhosis (*3*), lymphomas (*4,5*), and hematological disorders (*6,7*), but no systematic attempt to analyze the relative uptake of colloid in the RE system is available.

MATERIAL AND METHOD

We have reviewed all the liver and spleen scans done during 1969 in the Section of Nuclear Medicine of the Department of Radiology of the University of Chicago. From the total of 931 examinations, only 156 had *both* liver and spleen imaged *and* an initial referral diagnosis of cirrhosis, anemia (of unknown etiology), or systemic proliferative diseases and tumors of the hematopoietic tissues (*8*). These 156 cases constitute the present series.

It was suggested as early as 1952 (*9*) that the distribution of colloidal particles is dependent upon particle size. A description of our method of preparing ^{99m}Tc-sulfur-colloid is therefore relevant.

Following methylethyl ketone extraction of $^{99m}TcO_4^-$, and subsequent evaporation of the solvent, the desired activity is dissolved in 0.5 ml of pharmaceutical grade gelatin in 1 *N* HCl. Ten milliliters of H_2S gas is introduced into the preparation for 15 min at room temperature. The solution is then adjusted to pH 5–6 with 1 *N* NaOH and filtered through a 0.45-micron membrane (*10*).

Previous reports (*11–13*) have described the normal distribution of this colloidal nuclide: 80–90% goes to the liver, 5–10% to the spleen, and the rest to the bone marrow.

It is our practice to image the reticuloendothelial system with about 6 mCi of ^{99m}Tc-sulfur colloid and the gamma scintillation camera. Multiple views of the liver and spleen are taken with a minimum of anterior, posterior, and lateral projections for each organ. We obtain 10^6 counts/view in exposure times of 1–2 min.

The 156 scans were interpreted by one of us (AG) in a single session with no clinical information to determine the following: spleen size (*12*), liver size, relative uptake of radiocolloid by the spleen versus uptake by the liver, and uptake of radiocolloid by the bone marrow (*11*).

RESULTS

Decreased splenic uptake. In 24 scans the uptake of radiocolloid by the spleen was decreased in comparison with the uptake by the liver; the bone-marrow delineation was normal or not visible in 21 of these, and bone marrow uptake was increased in the remaining three. The final diagnosis in this group is shown in Table 1.

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TABLE 1. SPLEEN UPTAKE DECREASED (REGARDLESS OF SIZE); BONE MARROW UPTAKE NORMAL OR NOT VISIBLE

Final diagnosis	
Malignant lymphoma, histiocytic (reticulum cell sarcoma)	1
Hodgkin's disease	6
Malignant lymphoma, poorly differentiated lymphocytic	5
Chronic lymphocytic leukemia	2
Chronic granulocytic leukemia	1
Mycosis fungoides	3
Undifferentiated lymphoreticular neoplasm	1
Sickle cell anemia in crisis	1
Subacute bacterial endocarditis	1
TOTAL	21

TABLE 2. SPLEEN UPTAKE INCREASED (REGARDLESS OF SIZE); BONE MARROW UPTAKE INCREASED

Final diagnosis	
Cirrhosis	
with anemia (hematocrit 35% or less)	5
without anemia	4
Chronic active hepatitis with anemia	2
Iron deficiency anemia	1
TOTAL	12

TABLE 3. SPLEEN AND LIVER UPTAKE COMPARABLE (REGARDLESS OF SIZE); BONE MARROW UPTAKE NORMAL OR NOT VISIBLE

Final diagnosis	
Malignant lymphoma histiocytic (reticulum cell sarcoma)	6
Hodgkin's disease	20
Malignant lymphoma, mixed cell (histiocytic-lymphocytic)	3
Malignant lymphoma, poorly differentiated lymphocytic	7
Malignant lymphoma, well differentiated lymphocytic	2
Chronic lymphocytic leukemia	1
Granulocytic leukemia	1
Idiopathic thrombocytopenic purpura	3
Polycythemia vera	2
Myelosclerosis with myeloid metaplasia	3
Mycosis fungoides	6
Malignant histiocytosis	2
TOTAL	56

An iliac crest marrow biopsy was performed in 17 patients of this group. Twelve were abnormal (e.g., evidence of Hodgkin's disease, malignant lymphoreticular neoplasm, chronic lymphocytic leukemia). Nine of these 12 patients also had splenectomy; eight of the spleens were abnormal showing infiltration of hematopoietic neoplasms. Three other cases with decreased uptake of radiocolloid by the spleen had increased uptake in the bone marrow with the following final diagnosis: one—adenocarcinoma, metastatic to liver; one—valvular pulmonary stenosis with iron deficiency anemia; one—sickle cell anemia with lead intoxication. The surgical pathology report on the spleen in the last case of the series showed extensive areas of fibrous changes.

Increased splenic uptake. The uptake of radiocolloid by the spleen compared with the liver was *increased* in 13 cases. Only one of these cases, a patient with acute granulocytic leukemia with thrombocytopenia, had a normal appearing bone marrow on scintiphotography. The remaining 12 scans showed increased bone marrow uptake. The final diagnosis in this group is shown in Table 2.

Normal splenic uptake. Comparable uptake of radiocolloid by spleen and liver was found in 119 scans. In 56 of these the delineation of the bone marrow was considered normal, and the final diagnosis is shown in Table 3.

An iliac crest bone marrow biopsy was performed in 43 of these patients. Thirty of these biopsies were abnormal with substitutions of neoplastic cells, leukemic infiltrates, or fibrotic lesions. Splenectomy was done in 16 patients; the pathological report in 11 was normal, while five were infiltrated (four Hodgkin's disease, one mycosis fungoides).

Thirty-three scans had comparable uptake of radiocolloid by the spleen and the liver, but the uptake of colloid by the bone marrow was increased. These results are shown in Table 4.

The literature is replete with studies that correlate splenomegaly and increased bone-marrow uptake with cirrhosis or chronic hepatitis. Our results indicate that just as good a correlation to anemia is warranted with this scan appearance (see Table 5).

DISCUSSION

From this analysis it is clear that certain RE colloidal distributions have significant diagnostic implications (see Fig. 1).

TABLE 4. SPLEEN AND LIVER UPTAKE COMPARABLE (REGARDLESS OF SIZE); BONE MARROW UPTAKE INCREASED

Final diagnosis	
Cirrhosis	
with anemia (hematocrit less than 35%)	11
without anemia	6
Anemia	
iron deficiency	7
other causes	5
Proliferative diseases and tumors of the hematopoietic system without anemia	2
Others	2
TOTAL	33

TABLE 5. LARGE SPLEEN; BONE MARROW UPTAKE INCREASED

Final diagnosis	
Cirrhosis	
with anemia (hematocrit less than 35%)	13
without anemia	7
Anemia	
iron deficiency	5
other causes	5
Proliferative diseases and tumors of the hematopoietic tissues	1
Others	2
TOTAL	33

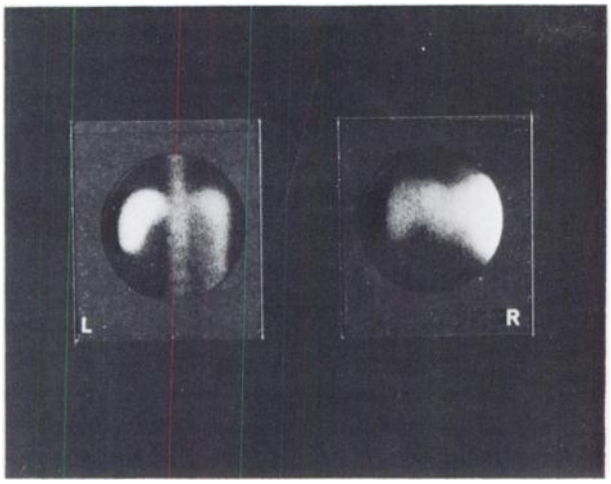

FIG. 1. Left is posterior view of abdomen (diverging collimator) showing markedly increased splenic uptake, increased bone marrow uptake, and relative decrease in hepatic uptake characteristic of either anemia or cirrhosis. Right is posterior view of left abdomen showing marked decrease in splenic uptake compared with liver, and no visualization of bone marrow. Spleen was not enlarged even though it was infiltrated with malignant lymphoma.

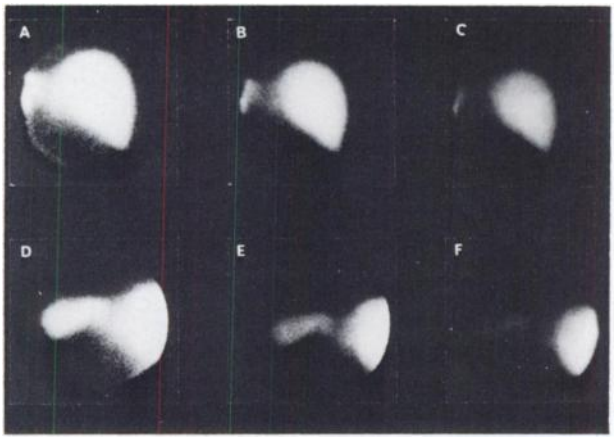

FIG. 2. Normal liver and spleen (surgical proof). Top row, ABC gives posterior view of liver showing conventional three-lens display (½ f stop increments) from Pho/Gamma III scintillation camera. Bottom row, DEF shows three-lens display of posterior view of spleen exposed for *same time* as liver with *same intensity* setting. Note that in normal case in our institution brightest exposure of spleen (D) corresponds in intensity to intermediate brightness display of liver (B). If splenic activity was increased, Exposure D would correspond best to Exposure A. If it was decreased, Exposure D would correspond to Exposure C. This simple technique facilitates subjective analysis of relative uptake in two organs. Since colloidal preparation used will effect splenic uptake, it is imperative that each institution establish its own normal appearance when using this technique.

When the uptake of radiocolloid by the spleen is decreased, and the bone marrow uptake is normal or not visible, the vast majority (19/21 or 90%) of this series showed hematopoietic neoplasms. This correlated well with widespread disease since over 70% of these cases showed positive bone marrow biopsies. Finally, in those cases for which pathologic study of the spleen was available, the scan appearance seems to be due to a widespread infiltration of the spleen by neoplastic tissue.

On the other hand, when the spleen shows an increase in uptake compared with the liver, virtually all of our cases also showed increased bone marrow uptake. In this case, a diagnosis of either cirrhosis or anemia is warranted, the correlation with either disease being about the same. When the bone marrow uptake is increased by itself, while the spleen is normal in appearance, the correlation with anemia or cirrhosis is also high.

It is important to point out that our interest was directed primarily to diseases of the recticuloendothelial system. Therefore, this series is deficient in conditions such as widespread metastatic adenocarcinoma, which might also alter the appearance of the colloidal scan.

A second limitation of this retrospective study is that no specific provision was made in our routine scanning techniques for the correlation of uptake of colloid in the liver and spleen. This can be done easily from the posterior projection either by including both liver and spleen on the same scan, or by taking a timed view of the posterior liver with a gamma camera, and exposing for the same period of time over the posterior spleen leaving the camera's intensity setting the same (Fig. 2).

CONCLUSION

This review was designed to assess the uptake of colloid in the various portions of the reticuloendothelium system in a variety of different diseases. The following useful patterns have emerged.

1. When the uptake of the spleen (regardless of its size) is decreased compared with that of the liver, and the bone marrow uptake is normal or diminished, the likelihood of systemic proliferative diseases and hematopoietic neoplasm is high (90% of this series).

2. When there is increased uptake in the spleen and bone marrow, there is a strong likelihood of *either* cirrhosis or anemia. The appearance is not specific for cirrhosis as has been suggested by others.

3. When the bone marrow alone shows an increased uptake, correlation to cirrhosis and anemia is again high.

The technique of subjectively assessing the relative uptake in liver and spleen from the posterior scan or camera study is comparatively easy, being a simple extension of the routine liver scan. This series suggests that it may be a useful adjunct to diagnosis.

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