RADIOISOTOPIC STUDIES OF CHANGES IN SPLENIC SIZE IN RESPONSE TO EPINEPHRINE AND OTHER STIMULI

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Uptake of radioactive colloid by the spleen, conventionally used to assess the gross morphology of the organ, can also be employed to gage the size of the spleen and its alteration following medications and other stimuli (*1*). We wish to report on the use of this procedure to demonstrate the decrease in splenic size in response to epinephrine in selected children with splenomegaly of sickle hemoglobinopathies. In addition, a review of literature data is presented on a number of conditions which alter splenic size, as well as possible techniques for quantifying these effects.

MATERIALS AND METHODS

As a background to this study, we required information as to splenic mobility to rule out possible rotation of the organ away from the detector system. We could find no definitive data in the literature. To examine this phenomenon, a review was made of all records from our laboratory during the previous 3 years in which two or more splenic scans had been performed on a patient. Of the first 100 records, only one revealed a change in the position of the spleen (Fig. 1). This was in a 20-year-old woman who had a renal transplant at the end of 1969. Two-and-a-half-months later she developed a high fever and leukocytosis of uncertain etiology. A liver-spleen scan was unrevealing. There was a defervescence of symptoms on antibiotic therapy. Six days after the first study, a repeat scan showed a marked change in the position of the spleen. With the exception of this single case, we have not been able to document changes in splenic rotation in other patients.

In the present study, ^{99m}Tc-sulfur colloid (15 μCi/kg) was injected intravenously and allowed to accumulate in the liver and spleen. The children (supine) were then positioned under a gamma-ray camera (coupled to a Nuclear Data 50/50 system), or under a cylindrically collimated probe system with spectrometer and scaler. After counts to assure stability of anterior activity over the spleen, epinephrine was injected through a previously started intravenous infusion. We followed contraction of the spleen by noting movement of the splenic tip past a reference

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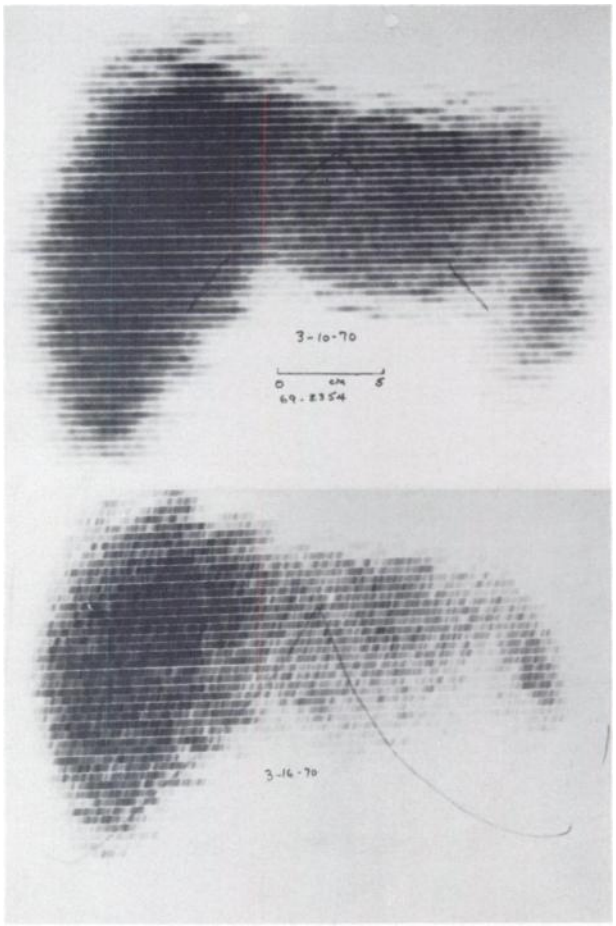

FIG. 1. Anterior ^{99m}Tc-sulfur colloid scans of liver and spleen in 20-year-old woman, 2½ months after renal transplantation. Lower scan was made 6 days after upper (and after antibiotic therapy).

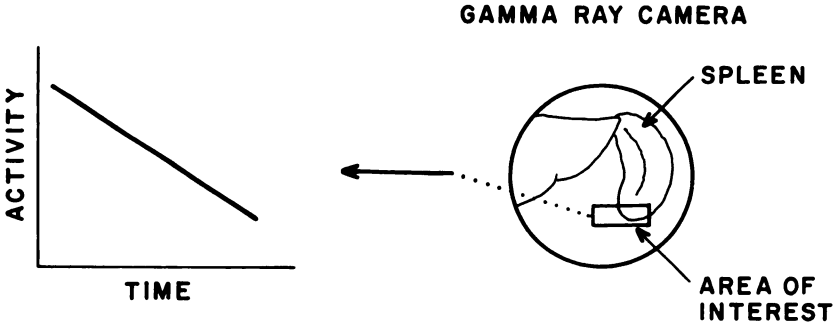

FIG. 2. Schematic diagram of technique for following contraction of splenic tip past reference point in grid system.

area in a grid system or away from the cylindrically collimated probe. The technique is described in Fig. 2.

Case 1. This Negro boy was first seen at age 5 years, 8 months. He had diagnosed sickle cell anemia with a hemoglobin of 6 gm/100 ml. On physical examination the spleen was palpable 9 cm below the costal margin. A ^{99m}Tc-sulfur colloid scan revealed even uptake in the liver but no significant activity in the spleen. Eight months after discharge, he was transfused in another hospital and returned for a repeat scan of the liver and spleen. The ^{99m}Tc-sulfur colloid scan now revealed uptake in the still palpable spleen (this case has been reported in a study of functional asplenia (*2*). The youngster was then placed supine on a stretcher beneath a gamma-ray camera which was coupled to a Nuclear Data 50/50 data processing system. Using the technique described above, epinephrine was administered via an intravenous infusion (0.0042 mg epinephrine/kg body weight were diluted in 30 ml of saline). The solution was given, and the time-activity curve over the spleen was recorded and later reconstructed (Fig. 3).

Case 2. A Negro girl was seen at age 14 years, 5 months, because of severe anemia. Hemoglobin electrophoresis revealed an SS pattern. A diagnosis of sickle cell-thalassemia was considered likely; however, confirmatory family study was not possible. On physical examination, the spleen was 11 cm below the costal margin. A ^{99m}Tc-sulfur colloid scan revealed uniform activity in a liver of 19 cm length. The anterior liver-to-spleen ratio of ^{99m}Tc was 80:3. The posterior ratio was approximately the same.

Epinephrine was also administered to this youngster with successive 1-min counts made about each 2 min with a 3-in. NaI(Tl) probe, scaler, and spectrometer. The cylindrically shielded probe was placed so that the tip of the spleen extended to approximately the midpoint of the aperture (Fig. 4).

RESULTS

In the first case, following epinephrine, there was both palpation evidence of a decrease in the size of the spleen and documentation of cephalad migration

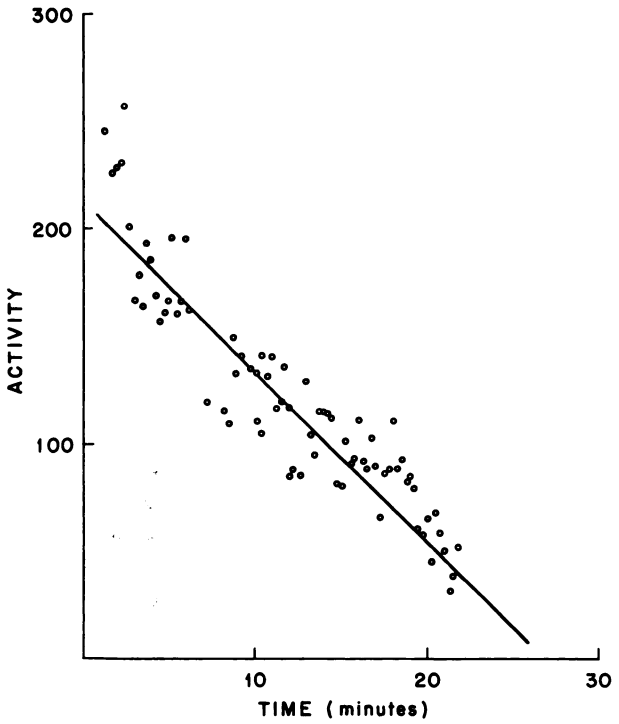

FIG. 3. Time course of change of radioactivity, as splenic tip migrated past reference grid in boy age 5 years, 8 months (^{99m}Tc-sulfur colloid previously given was radiolabel).

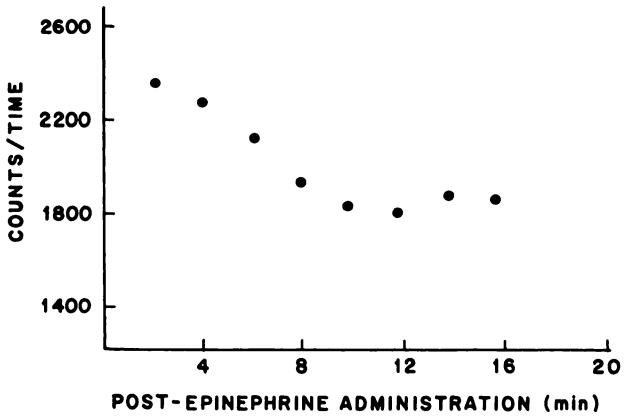

FIG. 4. Counts over splenic tip in girl aged 14 years, 5 months, following intravenous administration of epinephrine (^{99m}Tc-sulfur colloid previously given was radiolabel).

of the splenic tip by means of the gamma-ray camera-computer system. In the second case, there was also contraction of the spleen clinically and a fall in the counts per unit time as the splenic tip moved cephalad and hence out of the "view" of the probe. It should be pointed out that the dose of epinephrine employed was small and it was administered slowly. The kinetics of splenic contraction may be different after a large, acutely given dose of epinephrine; possible cardiovascular effects ruled out bolus administration of the medication.

DISCUSSION

Both of these children had splenomegaly due to major sickle cell hemoglobinopathy. It may be expected that in many older patients with sickle cell disease, an infarcted siderofibrotic spleen cannot respond to epinephrine. There appears little doubt, however, that in these cases there was splenic contraction in response to epinephrine. The technique can be extended to those with splenomegaly due to other causes. Although contraction of the congested human spleen has been suggested following epinephrine administration (*3*), further documentation by scanning techniques should be sought (and extended to the normal spleen).

We have attempted to tabulate some conditions which cause changes in splenic size (Table 1). In few of these conditions has there been adequate documentation by means of radioisotopic techniques. Burt and Kuhl (*8*) demonstrated by scintiscans a dramatic decrease in the size of a spleen involved by sarcoidosis following steroid therapy. Further studies along this line will be of importance to determine if the initial response to steroids (as determined from the scintiscans) can be used as a prognostic indicator. In a fine clinical study, Stuiver and coworkers (*9*) reported the decrease in splenic size following use of antimalarials in patients with the tropical splenomegaly syndrome.

The study of Burt and Kuhl (*8*), that of Stuiver and coworkers (*9*), and the report of the decrease in splenic size after hypertransfusion therapy of thalassemia (*10*), can be further analyzed. As a simple first approach, in each case we have set the initial spleen length at 100% [in the report of Stuiver and coworkers (*9*), the estimated spleen volume and not length was reported]. Each successively reported value was then expressed as a percent of the original value and plotted on a logarithmic scale as a function of time (Fig. 5). For the two studies reporting on length of the spleen (*8,10*), Fig. 5 reveals a "half-time" of decrease of 220 days. From values in the study of splenic volume in treated tropical splenomegaly (*9*), the "half-time" of decrease was 120 days. These values, on the order of many days, can be compared with the rapid (minutes) response of the enlarged spleen (in sickle cell anemia) to epinephrine.

TABLE 1. SOME CAUSES OF CHANGES IN SPLENIC SIZE IN MAN OR ANIMALS

Decrease size of spleen:	1. Arterial occlusion (*4,5*)
	2. Radiation effect (*6*)
	3. Pharmacologic agents
	a. Epinephrine (*3*)
	b. Ethyl palmitate (*7*)
	c. Corticosteroids (in sarcoid) (*8*)
	d. Malaria after therapy (*9*)
	4. Hypertransfusion, in thalassemia (*10*)
Increase size of spleen:	1. Intrasplenic or subcapsular bleed
	2. "Sequestration crisis" of sickle cell disease
	3. Obstruction of venous outflow (*1*)
	4. Methyl cellulose (*11*)
	5. Hydration, after dehydration (*12*)

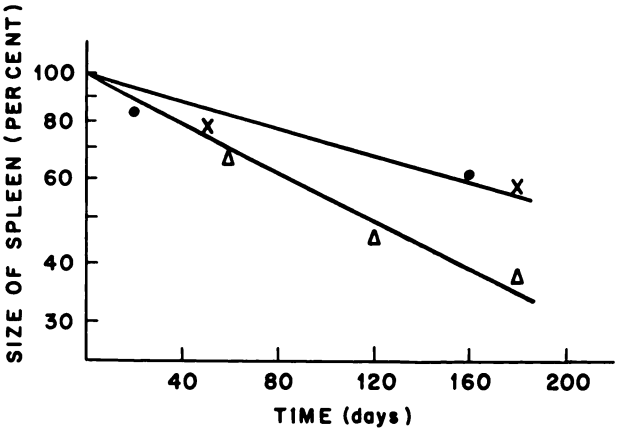

FIG. 5. Splenic size plotted on logarithmic scale as function of time. X marks are splenic length from report of Burt and Kuhl (on response of massively enlarged spleen in sarcoidosis to steroid therapy) (*8*). Dots are results of study on decrease in splenic length after hypertransfusion in thalassemia (*10*). Triangles represent estimated splenic volume after institution of antimalarial therapy in tropical splenomegaly (from values in ref. *9*).

While in their initial stages, such studies indicate that the spleen can change in size in response to various therapeutic regimes. Indeed, the scan-documented changes in splenic size might have diagnostic or prognostic significance (as, for example, in the sequestration crisis of sickle cell anemia mentioned in Table 1 but still inadequately studied).

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