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# Technetium-99m as a Label for Erythrocytes[2]

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In 1964 Harper *et al* first published a new method for the application of $^{99m}$Tc pertechnetate in thyroid and brain scanning (1). The extraordinarily favorable radiation characteristics of this radioisotope have made it the most desirable isotope for scintingraphy. Now it is used as a labeled compound for lung scanning (2), liver scanning (1), scanning of cardiac bloodpool (3), of bone marrow (4) and the kidneys (5). In scintigraphy of the liver using $^{99m}$Tc-labeled sulphur colloids, the spleen can be seen regularly, so that this organ may be scanned in this way. The method is reliable but not suited for isolated scintigraphy of the spleen. The spleen often cannot be differentiated from the left lobe of the liver. In the lateral position of the patient in which the greatest area of the spleen is visible (6), an overlapping with the liver shadow always occurs. For selective scanning of the spleen, therefore, the methods of $^{51}$Cr-labeled, heated erythrocytes (7-9, 6, 10-14, 15, 16-20, 21, 23) or of BMHP ($^{197}$Hg) (24, 25) incubated blood are preferable.

In both methods, artificially induced spherocytes are used as carriers of the radioactivity which must be deposited in the spleen. It seems reasonable, therefore, to try to label erythrocytes with $^{99m}$Tc and then to submit them to an alteration process and thus use the favorable radiation characteristics of $^{99m}$Tc for an isolated scintigraphy of the spleen. We have investigated this possibility and have found that it is possible under certain conditions, which must be strictly observed, to label erythrocytes with $^{99m}$Tc irreversibly and with high yield. About 12 ml of blood are withdrawn from the patient's cubital vein on 3 ml ACD solution.[3] The erythrocytes are separated from the plasma and then suspended in physiological saline solution. Then 1 mC $^{99m}$Tc-pertechnetate is added. The incubation time is about 20 minutes, then the labeled erythrocytes are washed twice with saline solution and resuspended in the patient's plasma and altered in a water bath at 49.5°C for 20 minutes. Immediately after finishing the alteration procedure, the erythrocytes are injected into the patient.

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The exact mechanism of the labeling process and its kinetics are still under investigation. $^{99m}$Tc-labeled erythrocytes may be used in the usual manner for the determination of the red cell mass. Their advantages are the low radiation burden for the patient and the short half-life of $^{99m}$Tc, which makes it possible to repeat the investigation after a short time without an increased background.

The binding of $^{99m}$Tc to the erythrocytes is very firm so that it is not broken up by a heat alteration of 49,5°C (20 min.). By means of such a preparation, $^{99m}$Tc-labeled, heat induced spherocytes are therefore available for the selective scintillation scanning of the spleen. After injection into the circulatory system, these spherocytes behave exactly like $^{51}$Cr-labeled, heat-altered erythrocytes (Fig. 1). Even *in vivo* no remarkable dissociation of technetium appears. The method is therefore also suited for the investigation of splenic blood flow and spleen function by means of the test we have developed (7, 8, 26-28, 29, 30). During the measuring period of 45 to 60 minutes, however, one has to make correction for the physical decay of technetium-99m.

Since the $^{99m}$Tc-labeled, heat-induced spherocytes accumulate selectively in the spleen, one obtains excellent scans even in cases of extreme splenomegalies (Fig. 2 and 3). In principle, it is only necessary to use 50 to 100 $\mu$C $^{99m}$Tc for labeling the erythrocytes in cases of moderate enlargement of the spleen. We prefer, however, to use higher activities, since the radiation burden is low and the quality of the scans can be improved as the result of better statistics. The scans shown in Figures 2 and 3 were made with 2 mC technetium (cpm on the Picker Magnascanner III = 20 000; 19-hole focussing collimator).

During an observation period of 48 h there is no substantial loss in activity of $^{99m}$Tc in the spleen by biological processes, so that the scanning can be repeated as long as the physical decay makes it possible.

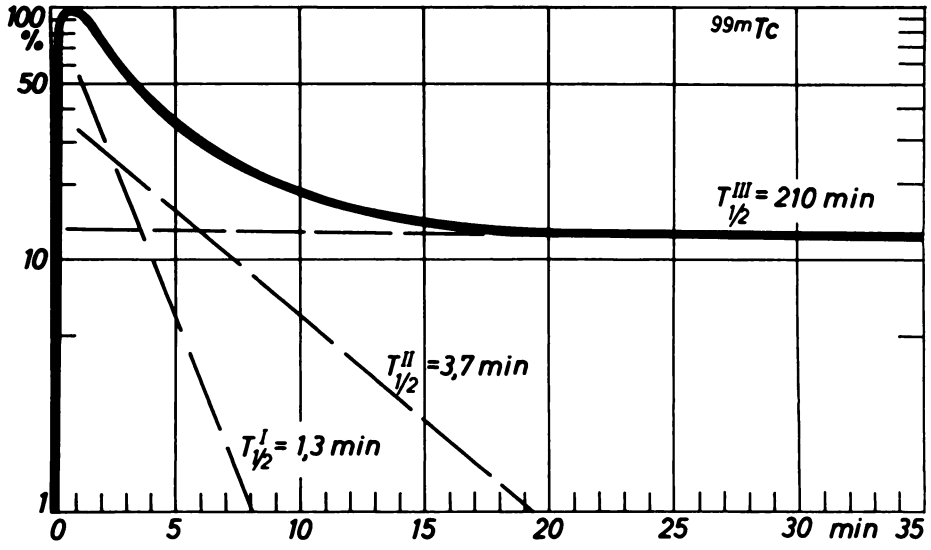


**Fig. 1. Blood clearance of $^{99m}$Tc-labeled, heated erythrocytes. Measurement using the ARMAC forearm-counter.**

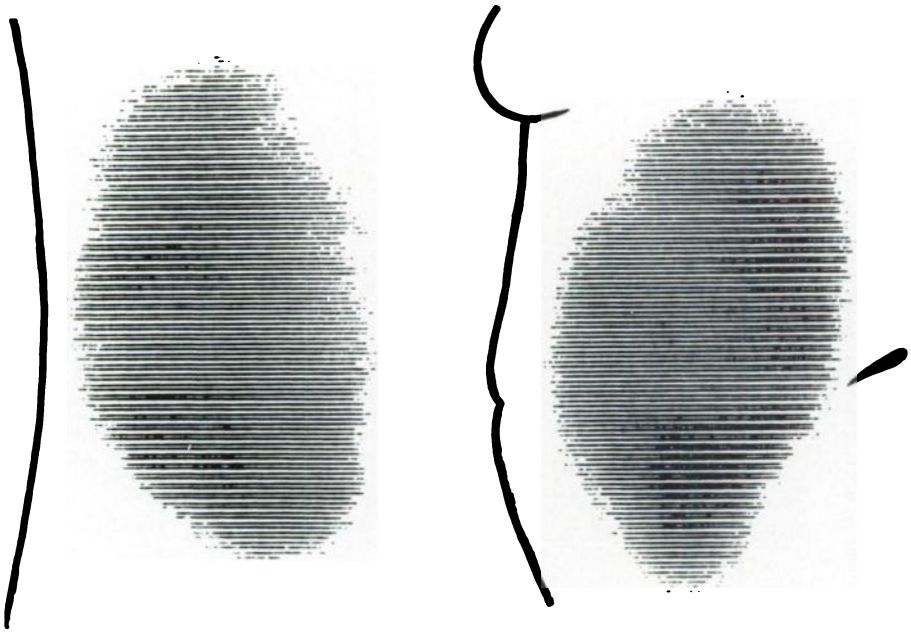

**Fig. 2 (left). Spleen scan using $^{99m}$Tc-labeled, heated erythrocytes. Supine position of the patient. It was a case of osteomyelofibrosis.**

**Fig. 3 (right). Lateral scan of the same patient.**

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