ABNORMAL BRAIN SCANS: CONTRIBUTION OF BLOOD RADIOACTIVITY TO IMAGE

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Images obtained with ^{99m}Tc-labeled red blood cells were compared with ^{99m}Tc-pertechnetate scans in 26 patients with primary and secondary brain tumors, intracerebral infarcts, and hemorrhage. The results indicated that the contribution of blood pool radioactivity to a positive brain scan was minor.

An intracerebral lesion may be demonstrated by brain scanning if it contains more radioisotope than the surrounding brain tissue. The relative contributions of vascular and extravascular radioactivity to the image are not known. The purpose of this study was to determine how often radioisotope confined to the blood compartment made a major contribution to the positive scan.

MATERIALS AND METHODS

Twenty-six patients were studied. Every patient had an abnormal ^{99m}Tc-pertechnetate scan and in every case histologic proof of the lesion that caused the abnormal brain scan was obtained (Table 1). Patients were divided into four groups on the basis of the histology of their lesion.

A brain scan was started 10 min after an intravenous injection of 10 mCi ^{99m}Tc-pertechnetate; 400 mg $KClO_4$ was given orally 30 min before the injection.

A labeled red cell brain scan was started 10 min after 16 ml of the patient's own blood labeled with 10 mCi ^{99m}Tc had been reinjected. The red cells were labeled according to the procedure of Eckelman, et al (*1*). One hour after the injection of ^{99m}Tc-labeled red cells, a blood sample was taken to determine the proportion of ^{99m}Tc bound to red cells.

All of the scans were taken on an Ohio-Nuclear Duo 5 scanner.

The time interval between a pertechnetate and a red cell scan ranged from 1 to 13 days with a mean of 3.9 days.

Both pertechnetate and labeled red cell scans were set up by assuming that the maximum counting rate from the patient's head would be obtained from the superior sagittal sinus. However, if the lesion could not be seen on the red cell scan, the study was repeated assuming that the maximum counting rate would be that obtained from the lesion itself. This was possible because the position of the lesion was always defined by the positive pertechnetate scan.

RESULTS

Typical scans are shown in Figs. 1 and 2. Figure 1 shows a meningioma that was detected on both scans; Fig. 2 shows an astrocytoma (Grade III) that was not detected on the red cell scan. It will be noted that the meningioma appears to be appreciably smaller on the red cell scan compared with the pertechnetate scan. This was characteristic of all of the lesions detected on the red cell scan. When a lesion could not be seen on a labeled red cell scan set up on the sagittal sinus, it was never possible to see it on a repeat scan set up on the lesion itself.

The red cell scan was abnormal in four of the seven patients with glioma, in two of the five patients with metastases from the bronchus, in five of the six patients with meningioma, and in four of the eight patients with cerebrovascular accidents.

One hour after the reinjection of ^{99m}Tc-labeled red blood cells, 92–97% of the circulating activity remained bound to the red cells.

DISCUSSION

During a red cell brain scan all of the circulating

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TABLE 1. PATHOLOGY AND RESULTS OF ANGIOGRAPHY AND ^{99m}Tc-RED CELL SCAN

Pathology			
Lesion	Histologic comment	Angiography*	Lesion seen on red cell scan
Astrocytoma III	Endothelial proliferation and necrosis	++	No
Astrocytoma III	Increased vascularity with endothelial proliferation and necrosis	+	No
Astrocytoma III	Endothelial proliferation and necrosis	0	Yes
Astrocytoma III	Endothelial proliferation and necrosis	++	Yes
Cerebellar astrocytoma	Endothelial proliferation and necrosis	0	No
Glioma	Necrosis	0	Yes
Oligodendroglioma	Marked endothelial proliferation	0	Yes
Metastasis from bronchus	Adenocarcinoma		No
Metastasis from bronchus	Poorly differentiated squamous		Yes
Metastasis from bronchus	Necrosis with cysts	0	No
Metastasis from bronchus	Well-differentiated squamous		No
Metastasis from bronchus	Anaplastic	0	Yes
Meningioma	Typical vascular meningioma	++	Yes
Meningioma	Typical vascular meningioma		Yes
Meningioma	Numerous small vessels throughout tumor	0	Yes
Meningioma	Moderately vascular with necrosis	++	Yes
Meningioma	Extensive capillary network		Yes
Meningioma	Numerous psammoma bodies		No
Intracerebral infarct	Necrotic brain tissue		No
Intracerebral infarct	Necrotic brain tissue	0	Yes
Intracerebral infarct	Necrotic brain tissue		No
Intracerebral infarct	Necrotic brain tissue	+	Yes
Intracerebral hemorrhage	Blood clot	0	No
Intracerebral hemorrhage	Blood clot	0	No
Subarachnoid hemorrhage	Blood clot	0	Yes
Subdural hematoma	Blood clot	0	Yes

* Vascularity in area of lesion as determined by angiography: 0, avascular; +, vascular; ++, very vascular.

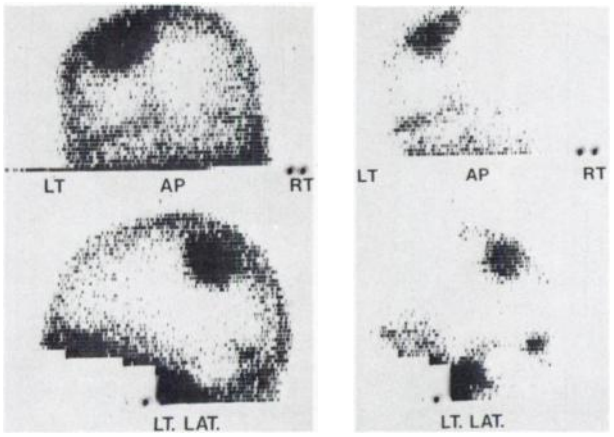

FIG. 1. (A) A $^{99m}TcO_4$ scan showing parasagittal meningioma and (B) ^{99m}Tc-labeled red blood cell scan of same patient.

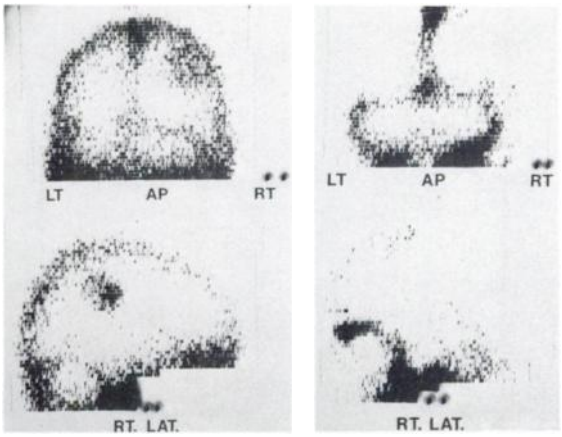

FIG. 2. (A) A $^{99m}TcO_4$ scan showing right parietal astrocytoma (Grade III) and (B) ^{99m}Tc-labeled red blood cell scan of same patient.

radioactivity was bound to the red cells. This agrees with Korubin, et al (*2*) who found little difference between the volume of distribution of pertechnetate and chromium-labeled red cells up to 2 hr. Since these tumors showed the characteristic vascular pattern (Table 1), it is therefore not surprising that all but one of the meningiomas could be detected on the red cell scan. The one meningioma that could not be seen on the red cell scan was situated in the posterior fossa and its histology was characterized by psammoma bodies and not increased vascularity.

The salient feature of this study was that only half of the remaining lesions could be detected on the red cell scan. Furthermore, there seemed to be no relation between the results of the red cell scan and the presence or absence of increased vascularity assessed histologically or by angiography (Table 1).

During a red cell scan almost all of the radioactivity

remains in the circulation. During a pertechnetate scan radioactivity is lost rapidly from the vascular compartment so that by the end of a scan less than half of the initial radioactivity remains in the blood (*3,4*). This means that during a red cell scan the concentration of radioactivity in the blood was at least twice that present during a pertechnetate scan. In spite of this only half of the gliomas, metastases, and cerebrovascular accidents could be demonstrated on the red cell scan. Furthermore, when a lesion was detected on a red cell scan, it was always smaller and less obvious than on the corresponding pertechnetate scan. This difference was seen in all of the lesions irrespective of their histology. Since the red cell and pertechnetate scans were all set up within 10 min of the injection of isotope, only a fraction of this difference can be explained on instrument settings. It therefore seems that radioactivity confined to the blood pool makes a relatively small contribution to a positive pertechnetate brain scan. This supports the hypothesis that, when a lesion is detected on a pertechnetate scan, the bulk of the radioactivity is in the extravascular compartment.

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