CHLORMERODRIN-^{197}Hg BRAIN SCANNING: SELECTING THE OPTIMAL INTERVAL BETWEEN ISOTOPE ADMINISTRATION AND SCANNING

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The 4–5-hr interval between the administration of chlormerodrin labeled with radioactive mercury and scanning which was first suggested by Blau and Bender (*1*) is now routine in most institutions; however, shorter intervals have been recommended (*2–4*). With chlormerodrin-^{197}Hg a 3–5-hr interval was used initially in our laboratory (*5–7*) but later a 15–30-min scan was used as Tabern suggests (*4*). The increased false-negative rate associated with this shorter interval led to the initiation of this study to determine the optimal interval between administration of chlormerodrin-^{197}Hg and brain scanning.

METHOD

Data from 25 patients who had abnormal uptake of chlormerodrin-^{197}Hg on brain scans provide the basis for this study: 20 patients had intracranial tumors, and five had cerebral infarcts. The intracranial tumors included eight metastatic lesions, five meningiomas, three glioblastomas and four miscellaneous lesions (Table 1). The diagnosis of tumor was histologically verified with the exception of four cases in which an extracranial metastatic tumor had interdicted surgery. Five cases of cerebral infarcts associated with focal areas of abnormal uptake on scans are included in this study. Some of the results from the metastatic tumors and cerebral infarcts have been reported previously (*8,9*).

TABLE 1. TIME OF OPTIMAL TARGET-TO-NON-TARGET RATIO

		Time of count					
Type of lesion	No. of cases	Immediately	1 hr	2 hr	3 hr	4 hr	5 hr
Tumor	20						
Metastatic	8				1	2	5
Meningioma	5	1			1	1	2
Glioblastoma	3					1	2
Oligodendroglioma	1						1
Meningeal sarcoma	1				1		
Hemangioblastoma	1						1
Cerebellar astrocytoma	1	1					
Cerebral infarct	5				1	2	2
Total	25	2	0	0	4	6	13

All patients were studied after the site of their lesions had been determined by a prior brain scan or by some other neuroradiological study. If a prior scan had been made, the study was delayed until the counting rate over the cranium and the tumor was down to the background counting rate in the scanning laboratory. No study was made less than 72 hr after a previous scan. In the two patients who had carotid angiography before the study, the interval between the angiographic and the isotope study was 3 days.

Each patient received 900 μc of chlormerodrin-^{197}Hg. Counting rates were obtained from three regions: (1) directly over the lesion, (2) from the vertex and (3) from the "cold" area (area on the cranium with the lowest counting rate). The counting rate was recorded immediately after injection of the isotope and at hourly intervals up to 5 hr afterward. Pulse-height acceptance of 50–100 kev was used. Counts on the vertex and the "cold" area correspond to the extremes of counting rate over the cranium in a normal scan. Counting rates were obtained using a 3 $\times$ 2-in. NaI(Tl) crystal and a 19-hole, 3-in. focusing collimator. In selected cases lateral photoscans from the side of the head harboring the tumor were made 15 min and 3–4 hr after the injection of the isotope (Figs. 1–4).

A ratio of the target-to-non-target counting rate was then calculated. The non-target counting rate was obtained by averaging the counting rate from the two normal areas sampled (vertex and "cold" areas). For each lesion the time interval that resulted in the highest ratio was the optimal one for displaying the lesion on the scan.

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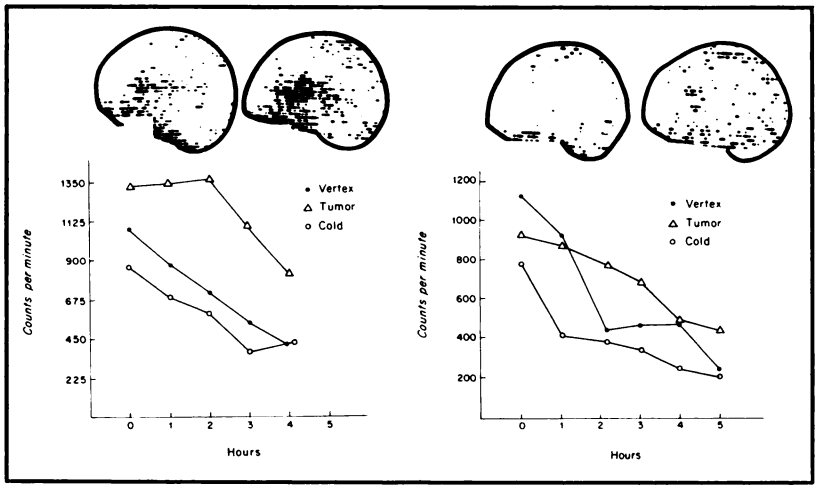

FIG. 1. Lateral photoscans (facing left) and counting-rate curves from two different patients with cerebral metastatic tumor. Photoscans on left of each pair were started 15 min after administration of isotope; those photoscans on the right of each pair were started 3 hr later. Counting-rate curves are below scans in each case. In the left pair of photoscans, tumor was satisfactorily displayed on both 15-min and 3-hr scan; however, tumor-to-non-tumor ratio was more discriminating at 3 hr than earlier. In the right pair of photoscans, tumor was not displayed at 15 min but was noted at 3 hr after administration. Counting rate from tumor did not exceed the counting rate from the vertex until 1 hr after injection.

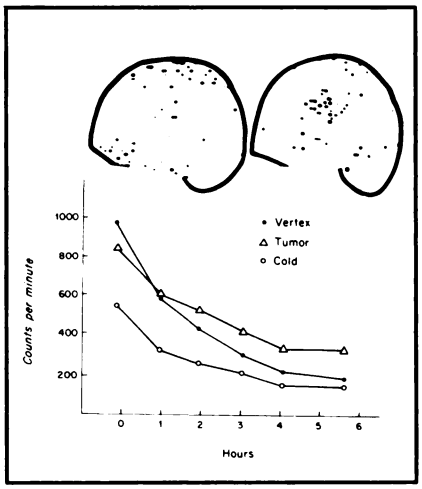

FIG. 2. Lateral photoscans (facing left) and counting-rate curve from patient with frontoparietal glioblastoma. Immediately after administration of isotope, tumor counting-rate was lower than that from vertex. Optimal tumor-to-non-tumor ratio was obtained after 5 hr. Tumor was displayed better at 3 hr (right photoscan) than at 15 min (left photoscan).

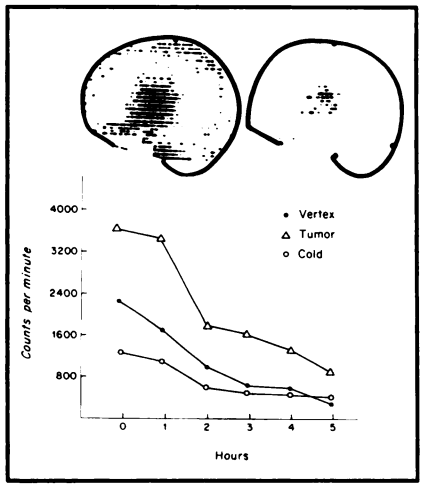

FIG. 3. Lateral photoscans (facing left) and counting-rate curves from one patient with left frontoparietal meningeal sarcoma. Tumor is adequately displayed at 15 min (left photoscan) and at 3 hr (right photoscan). Optimal tumor-to-non-tumor ratio was obtained at 3 hr.

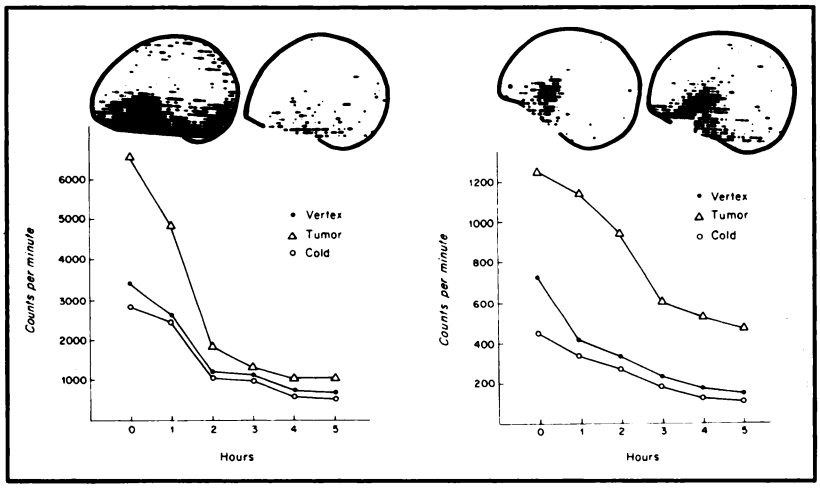

FIG. 4. Lateral photoscans (facing left) and counting-rate curves from two different patients with sphenoid ridge meningioma. Photoscans on left of each pair were started 15 min after administration of isotope; those on right were started 3 hr later. In left pair, tumor was one of two in series with optimal tumor-to-non-tumor ratio immediately after administration of isotope. The 15-min scan displays tumor better than does 3-hr scan. In right pair, tumor was displayed well on both scans and had its optimal tumor-to-non-tumor ratio at 5 hr.

RESULTS

The optimal target-to-non-target ratio from 18 of the 20 tumors was obtained 3–5 hr after the administration of chlormerodrin-^{197}Hg; the remaining two tumors—one meningioma (Fig. 4) and one cerebellar astrocytoma—were optimally displayed immediately after the isotope was administered. More tumors had their optimal ratio at 5 hr than at any other time (Tables 1,2; Figs. 2,4).

None of the five cerebral infarcts had its ratio of optimal display less than 3 hr after isotope administration (one had an optimal time of 3 hr, two of 4 hr and two of 5 hr).

The target-to-non-target ratios of counting rates ranged from 1 to 8.69. The highest ratio (8.69) was obtained at 5 hr from a glioblastoma. Eighty-five percent of the lesions studied had optimal ratios between 2 and 4; however, the optimal ratios of the 25 lesions in the study ranged from 1.25 to 8.69. Table 3 lists by hourly intervals the average target-to-non-target ratio for each type of lesion studied.

TABLE 2. TIME OF OPTIMAL TUMOR-TO-NON-TUMOR RATIO

Time of count	No. of tumors with optimal ratios
Immediately	2*
1 hr	0
2 hr	0
3 hr	3
4 hr	4
5 hr	11
Total	20

* Cerebellar astrocytoma and meningioma.

COMMENTS

This study shows that the 3–5-hr interval is more discriminating than any shorter one when one scans for brain tumors with chlormerodrin-^{197}Hg; moreover, the 5-hr interval is preferable. A longer time might be beneficial, but in most institutions the time needed for injections and scanning consumes enough of the usual 8-hr working day so that it is not possible to consistently lengthen the interval beyond 5 hr. Scanning on the day after injection is not useful because the counting rate is too low.

The fact that two tumors had optimal target-to-non-target ratios immediately after isotope administration indicates that results can be improved by using an early as well as a late scan. However, the time required to complete the scan and the great demand for scans make repeat scanning impractical in most laboratories. In addition, immediate or early scanning may produce such prominent vascular shadows that they hide some lesions and obscure the margins of others adjacent to them.

Brain-tumor display produced by an intravascular isotope should be optimal immediately after intravenous administration, whereas display produced by the abnormal permeability of the blood-brain barrier should be optimal after time has elapsed for the extravascular deposition of the isotope. The late instead of immediate display of most tumors in this series indicates that the extravascular accumulation of the isotope is the more important factor in tumor display. In the present series even a richly vascular hemangioblastoma, a meningeal sarcoma and four of the five meningiomas were optimally displayed at 3–5 hr instead of earlier.

The overlap between tumor types of optimal tumor-to-non-tumor ratios and time of optimal uptake was so great that neither of these factors proved helpful in predicting the histologic diagnosis. We hoped that the time curves of uptake might prove useful in differentiating a tumor from an infarct, but there was considerable overlap among curves from tumors and infarcts.

TABLE 3. AVERAGE TUMOR-TO-NON-TUMOR RATIO FROM EACH TUMOR TYPE

Type of lesion	No. of cases	Time of count: Immediately	1 hr	2 hr	3 hr	4 hr	5 hr
Tumor							
Metastatic	8	1.31	1.34	1.80	2.11	2.35	2.58
Meningioma	5	1.88	2.05	2.14	2.21	2.77	2.72
Glioblastoma	3	1.49	1.84	2.36	2.61	3.50	5.27
Meningeal sarcoma	1	2.08	2.53	2.27	2.75	2.51	2.31
Hemangioblastoma	1	2.70	2.34	3.46	3.10	3.89	4.68
Oligodendroglioma	1	1.19	1.38	1.73	2.08	2.10	2.43
Cerebellar astrocytoma	1	2.13	1.68	1.78	1.88	1.91	1.75
Cerebral infarct	5	1.35	1.42	1.57	1.93	2.26	2.06

SUMMARY

Twenty-five patients with abnormal uptake on brain scans made with chlormerodrin-^{197}Hg were studied to determine the optimal interval between isotope administration and scanning. Twenty patients had tumors, and five had cerebral infarcts. Eighteen of the 20 tumors had optimal tumor-to-non-tumor ratios of counting rates 3–5 hr after injection. All five cerebral infarcts were optimally displayed 3–5 hr after injection. None of the counting times was extended beyond 5 hr.

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