COMPARISON OF ACCURACY BETWEEN INITIAL AND DELAYED ^{99m}Tc-PERTECHNETATE BRAIN SCANS

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Although brain scanning is only slightly more than 20 years old, it has become an invaluable diagnostic aid in the evaluation of patients with suspected intracranial disease. The major growth in brain scanning occurred when a 3-in. sodium iodide crystal detector rectilinear scanner became commercially available and ^{203}Hg-chlormerodrin was introduced as a brain scanning agent (*1*). It was customary at that time to delay the scans 3–4 hr after mercury injection to obtain maximum or optimum target-to-nontarget ratios of radioactivity (*2–4*). With the introduction of ^{99m}Tc-pertechnetate as an improved brain scanning agent (*5*) this time delay was abandoned in most laboratories, and the scans were begun within the first hour after injection (*6–10*). Data have since accumulated suggesting that this is not the optimum time to begin scanning and that better target-to-nontarget ratios are obtainable if scans are performed 3–4 hr after injection of pertechnetate (*11–14*). In an effort to determine the usefulness of the delayed brain scan technique, we have performed a prospective study.

TABLE 1. CHANGES IN SCAN DENSITY OF VARIOUS BRAIN LESIONS ON INITIAL AND DELAYED RECORDINGS

Lesion	Density on delay			
	In-creased	Same	De-creased	Total
Meningioma	1	5	2	8
Astrocytoma	4	—	—	4
Glioblastoma multiforme	10	3	—	13
Acoustic neurinoma	—	3	2	5
Metastases	10	5	2	17
Infarct	10	8	—	18
A-V malformation	—	2	—	2
Miscellaneous	4	3	—	7
Total	39	29	6	74

MATERIALS AND METHODS

During the 4-month period from October 1970 to February 1971 all patients with abnormal brain scans recorded immediately after injection of ^{99m}Tc-pertechnetate had repeat views done 3–4 hr later. In addition, five patients with initially negative scans also had delayed studies. One of these was a brain tumor suspect, two were suspected cerebrovascular accidents, and two had large subarachnoid cysts. A dose of 10–20 mCi of ^{99m}Tc-pertechnetate was used. The patients were pretreated with 400–800 mg of potassium perchlorate prior to injection to decrease choroid plexus uptake. Rectilinear scanners with focused 19-hole collimators, contrast enhancement, and 2 × 3-in. NaI(Tl) crystals were used to obtain the scans.

RESULTS

Seventy-four cases were included in the study. The abnormal uptake on the initial and delayed scans was evaluated for film density and margin delineation. The density was rated on a scale of four, with three being equal to vertex activity, four and two being greater or lesser than vertex activity, and one being barely discernible. Of the 74 cases the density of the abnormal uptake increased on the delayed scan in 39, remained unchanged in 29, and decreased in six (Table 1). The individual lesion changes are graphed in Fig. 1. In almost all instances the margins of the abnormality were more clearly delineated on the delayed scans as had been previously reported (*13,14*).

Five cases had initial scans which were normal. Three of these, one glioblastoma and two cerebro-

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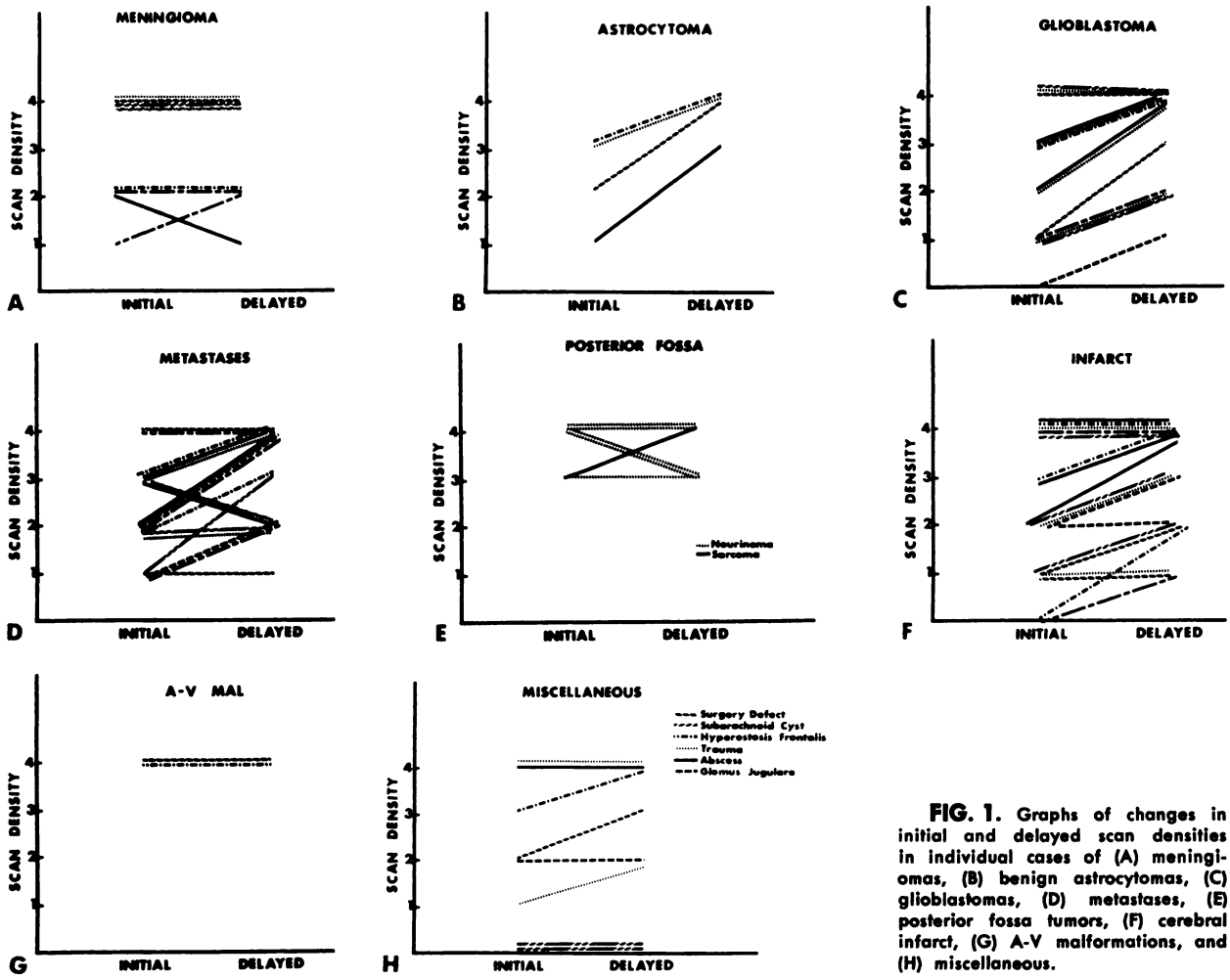

FIG. 1. Graphs of changes in initial and delayed scan densities in individual cases of (A) meningiomas, (B) benign astrocytomas, (C) glioblastomas, (D) metastases, (E) posterior fossa tumors, (F) cerebral infarct, (G) A-V malformations, and (H) miscellaneous.

vascular accidents, became positive on the delayed scan while the two subarachnoid cysts remained normal. The subarachnoid cysts were included in the study because the fact that such large lesions remained normal gives a possibly valuable diagnostic clue in future cases where this diagnosis is considered.

With the exception of one meningioma and two acoustic neuromas, scans which were initially four plus positive were unchanged on the delayed study.

With regard to improvement in detectability of lesions during the period of time of this investigation, none of the 17 cases of metastases showed lesions on the delayed scans which were not identified on the initial study. There was one case of glioblastoma which went from negative to one plus positive, and cerebrovascular accidents went from negative to positive. Representative scan changes for benign astrocytoma, glioblastoma, metastases, and infarct are seen in Figs. 2–5.

DISCUSSION

Since we began using ^{99m}Tc-pertechnetate as our routine brain scanning agent in 1964, we have had positive brain scans in 502 of 566 (88.7%) of proved or probable brain tumors. This percent positive increased to 93% (94 of 101) during the 12-month period from January 1970 to January 1971. Our routine has been to begin brain scanning within 15 min after the injection of pertechnetate. Our series has a higher percentage positive than others (*15*) because we do almost no scans on pituitary tumor suspects because of the low information retrieval it provides. Gates, et al (*14*) report only 80% accuracy on the initial scans which increased to 93% using the delayed scan technique. In their work they suggested that the brain scan be started immediately after injection and if positive not be repeated. But if in a brain tumor suspect the scan is negative, then they recommend delayed scanning. Only 12–15% of all of our brain scans performed

are positive. Following such reasoning would mean doing delayed scans on 70–75% of our normal brain scans because most of these patients are brain tumor suspects. However, because one patient with a glioblastoma in this series had a positive scan only on the delayed views and because of reports of abnormalities appearing in patients with metastases on the delayed scans, we changed our brain scanning procedure and now begin our scans 2 hr after injection. It was not possible, logistically, to change to the 4-hr postinjection technique.

Of special interest in this study were the cases of cerebral infarct which went from negative to positive on the delayed scan. This may well explain the differences between our experience with stroke cases and that of Swedish workers. Approximately 25%

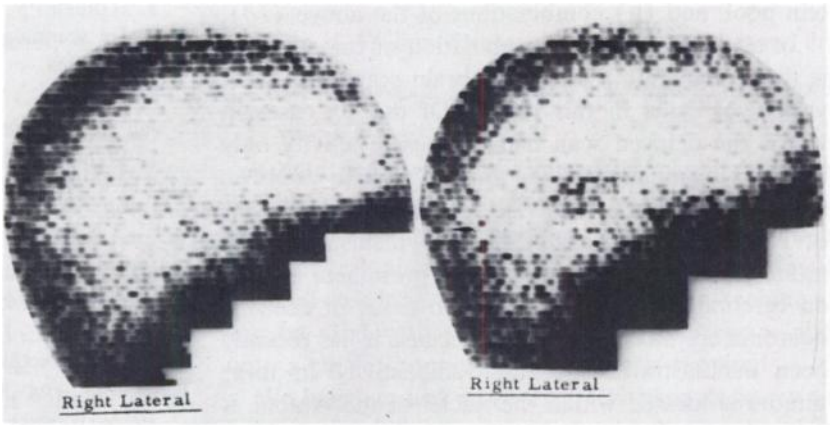

FIG. 2. Initial and delayed scans in patient with Grade 2 astrocytoma. Note that on initial scan abnormality is barely visible but is more clearly seen on delayed scan.

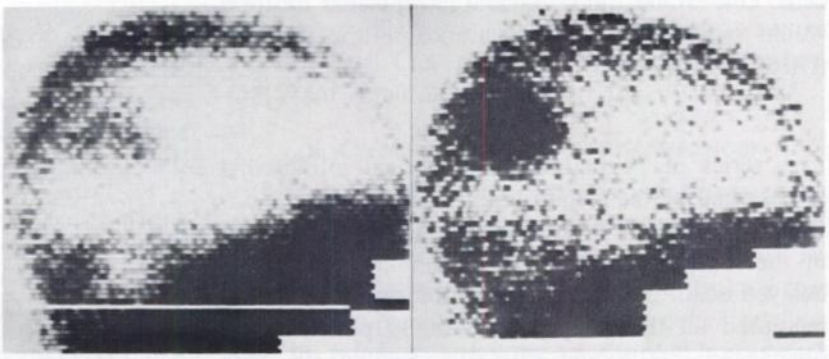

FIG. 3. Initial and delayed scans in patient with Grade 4 astrocytoma (glioblastoma multiforme). Margins are more clearly seen on delayed scan.

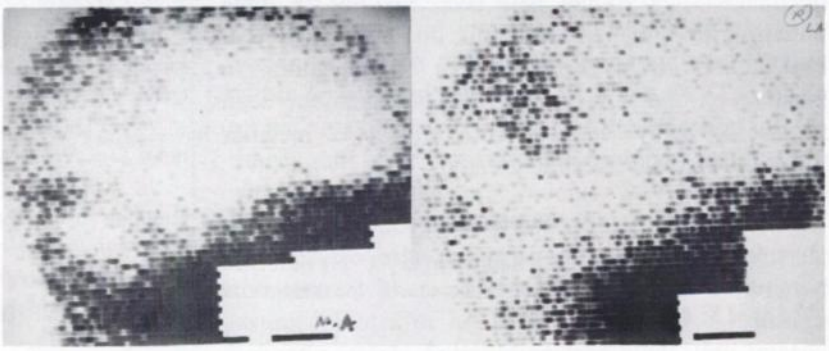

FIG. 4. Initial and delayed scans in patient with melanoma metastases. Note more clearly defined and more dense appearance on delayed scan.

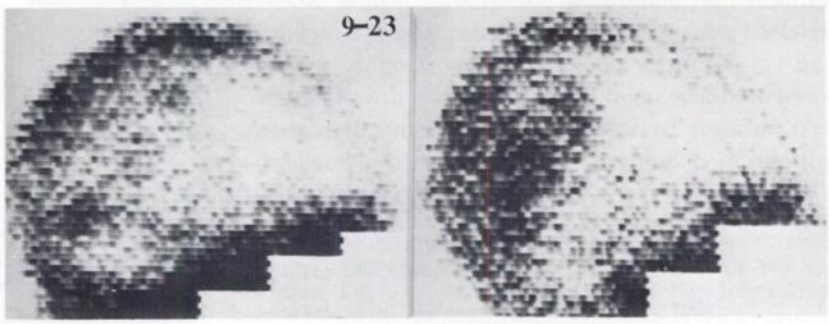

FIG. 5. Initial and delayed scans on patient with cerebral infarct. Note clearer definition of lesion on delayed view.

of patients have positive scans the first week after a cerebrovascular accident when the scan is performed immediately after injection (*16*). Cronquist in Lund finds more than 60% positive scans in the first week after cerebral infarct (*17*). He routinely starts scans 4–6 hr after injection.

The major mechanisms for brain scans being abnormal are: (A) neoangiogenesis with capillary pore leaking, (B) microvascular damage, (C) increased regional blood volume, (D) increased regional protein pool, and (E) combinations of the above (*18*).

In all probability the combination of these factors is the explanation for positive brain scans in a wide variety of cases in this report. Of the six cases in which the delayed scan had decreased activity only the two meningiomas had large vascular pools in which the decrease might be explained on the basis of blood pool clearance. The two metastases, pulmonary and stomach, did not have prominent blushes on cerebral angiography. The two cases of acoustic neuroma are more of a puzzle because it has recently been demonstrated that the radioactivity in these tumors is located within the nuclei of the Antoni A cells. One would think that the intranuclear location would indicate a slower clearance of the radioactivity.

SUMMARY

A series of 74 patients with proven intracranial disease had pertechnetate brain scans performed immediately and 3–4 hr after injection. The delineation of the lesions was almost always improved on the delayed scan. The scan density of the abnormality increased on the delayed scan in 39 patients, was unchanged in 29, and was decreased in six. One patient with a malignant glioma and two with cerebral infarcts went from negative on the initial to positive on the delay. We have changed our scan routine to delay scanning until at least 2 hr after injection of the pertechnetate.

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