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THE DIAGNOSIS AND LOCALIZATION OF INTRACRANIAL TUMORS WITH RADIO-ACTIVE MERCURY (Hg^{203}) BRAIN SCANNING

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Within the past two or three years radio-active mercury brain scans have become the most valuable single diagnostic test for the demonstration and localization of intracranial tumors. In the Autumn of 1961 Dr. E. A. Kahn and his associates at the University of Michigan introduced us to this diagnostic procedure. We began using it in May 1962 and in the following 19 months (May 1962 to January 1964) 233 patients were examined with this technic on our Service at the Chicago Wesley Memorial Hospital. Of these patients 69 have been proved to have had a brain tumor. There were also 42 cerebrovascular disorders, 10 epidural and subdural hematomas, 5 arteriovenous malformations, 36 convulsive disorders of non-neoplastic etiology and a number of other miscellaneous conditions.

Brain scanning using radio-active isotopes is not new. It was begun in late 1940's by George E. Moore at the University of Minnesota; subsequently a number of investigators reported on the use of the method which Moore initiated (Moore, 1948 [7]; Moore, 1953 [8]; Peyton, Moore, French and Chou, 1952 [9]; Davis, Martin, Ashkenezy, Leroy and Fields, 1950 [4]; Dunbar and Ray, 1954 [6], and others). The first reports were most enthusiastic but with increased experience it became necessary to publish retractions of this enthusiasm (Davis and Craigmile, 1954 [5]) and the method fell into disuse in most clinics.

In the cases reported upon here we have used the method as originally described by Brinkman, Wegst and Kahn [3]. Since then we have used Hg^{197} (Sodee [10]) instead of Hg^{203} (Bender and Blau [1, 2]). The main ad-

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vantage of Hg^{197} is that it has a very short physical (2.7 days) and biological half-life and as a result the radiation to which the kidney is exposed is reduced approximately 100 times as compared with Hg^{203}. With Hg^{197} no premedication with mercuhydrin is required. The scans with the two isotopes are comparable. There have also been some modifications in the scanners which we are using. These, however, are changes designed to increase the safety of using radio-active materials and to improve the accuracy of recording. These changes have not influenced the overall results of this diagnostic procedure nor have they altered our general opinion of it. There are good reasons to hope that in the near future further changes, particularly in the recording equipment, will be made which will greatly shorten the time required for the examination of the individual patient. At present our equipment requires approximately 30 minutes for each view. Thus if we make two lateral, an anterior and a posterior scan two hours are required for the examination. In every case at least two views are required, and in many three or four are necessary or advisable.

In performing these brain scans we have used Neohydrin prepared with Hg^{203}. The Neohydrin was given intravenously, 10 microcuries per kg of body-weight, with the total dose not exceeding 700 microcuries. The Neohydrin is excreted through the kidneys which were protected from the radio-active Neohydrin by giving 1 cc of mercuhydrin (non-radio-active) subcutaneously 10 to 12 hours before the isotope was injected *. The scanning was carried out 3 hours after the isotope was injected. The scanning technic is essentially the same as that described by Brinkman, Wegst and Kahn [3]. A method of photorecording on film is used, which is capable of resolving and emphasizing even small differences in radioisotope concentrations between the tumor and the brain tissue.

Radio-active mercury brain scans are useful in the diagnosis of various types of brain tumor, but they are not equally useful in all types. In our experience the highest percentage of positive results have been obtained with glioblastomas and with meningiomas. Even here the results are not 100% positive. We have had one case of cerebral glioblastoma in which the radio-active mercury brain scan was never absolutely positive and localizing, although ventriculography finally demonstrated the presence and location of the tumor which was confirmed at operation. We had another case of cerebral glioblastoma in which early in the course of the tumor the brain scan was not diagnostic but a month later it was of the greatest diagnostic value, especially as neither angiography nor pneumoencephalography provided accurately localizing information. However, in 87.5% of 24 scans in cases of glioblastoma the method was positive and accurately localizing (Fig. 1). Radio-active mercury scanning proved of greatest help in a number of cases of glioblastoma in which clinical examination, pneumoencephalography, cerebral angiography and electroencephalography did not provide accurately localizing diagnosis.

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* This precaution is not necessary when mercury ^{197} is used.

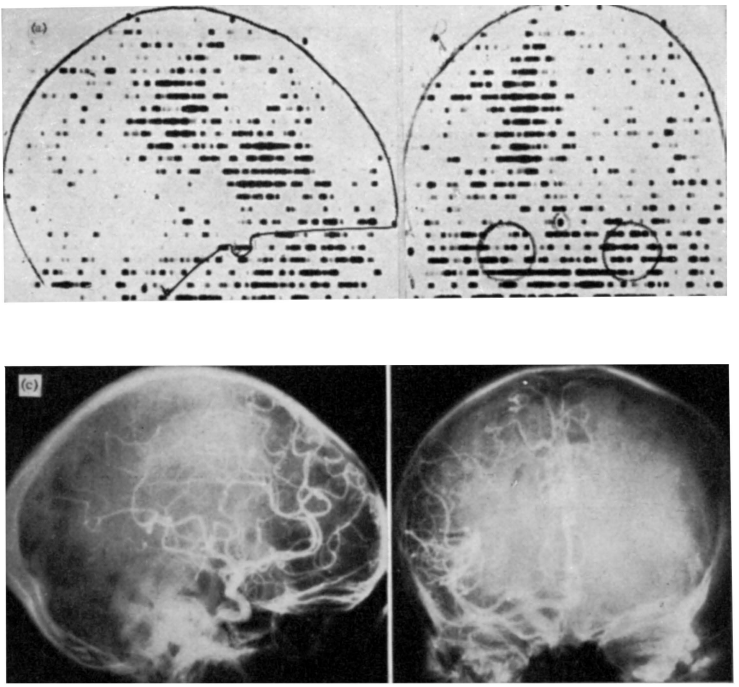

Fig. 1 — Glioblastoma, right fronto-parietal: a) radio-active mercury brain scan, right lateral, large tumor being demonstrated; the inactive area lying antero-superiorly was due to a cystic cavity; b) anterior brain scan showing tumor deep seated in right cerebral hemisphere; c) right carotid angiogram, lateral view, showing a few abnormal smal vessels in the central area; d) right carotid angiogram, antero-posterior view, normal.

Our results with meningiomas were even more gratifying. Scanning was positive and localizing in every one of 13 cases. Furthermore, in general, meningiomas showed the most intense radio-active "pick-up". In one case of multiple meningiomas the radio-active scan revealed the multiplicity of the lesions. There were also several cases in which the radio-active scans not only revealed the tumor to much better advantage than other methods, such as angiography, but were so much more accurate in their localizing significance as to greatly aid the surgeon in planning his operative attack. This was particularly true with a meningioma of the occipital pole which was not demonstrated by angiography (Fig. 2) and in another case with a meningioma lying along the falx in the parietal region (Fig. 3). In the latter case the angiograms indicated the presence of a tumor in the parietal area but did not disclose that the tumor was a meningioma, nor indicate that it lay so far medially. In all we have had 3 cases in which only the

radio-active mercury brain scan disclosed the presence and location of the meningioma, while the angiogram was either negative or failed to localize the lesion.

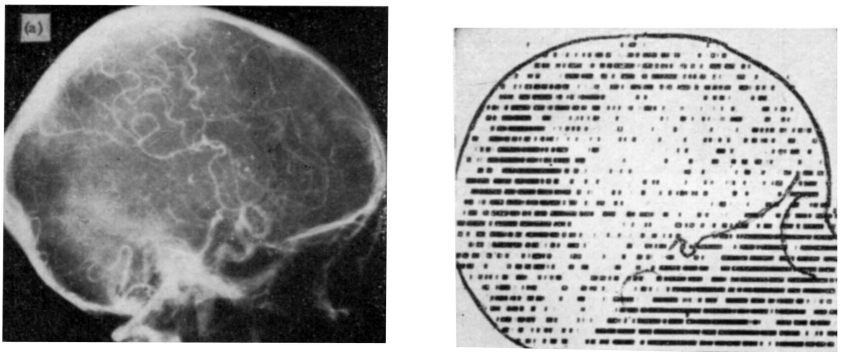

Fig. 2 — Meningioma, occipital: a) cerebral angiogram is not diagnostic; b) brain scan accurately localizes tumor.

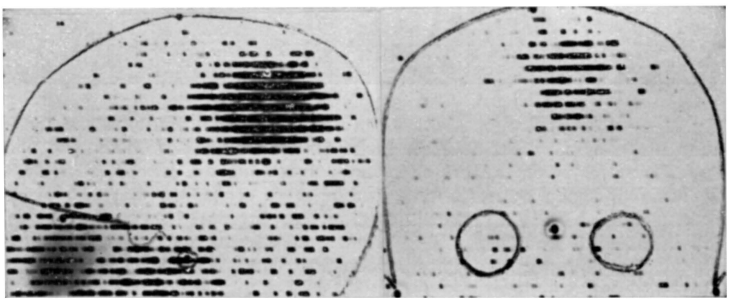

Fig. 3 — Meningioma parasagittal, parietal. The radio-active mercury brain scan clearly and accurately discloses the presence and location of this tumor.

Radio-active brain scans have given positive results in only 50% of 4 cases of cerebral astrocytoma. In one of these there was a very large astrocytoma in the right temporal region clearly demonstrated by cerebral angiography while the brain scan was silent (Fig. 4). A radical extirpation was made. A year and a half later the patient developed a few temporal lobe type seizures and was re-examined. On this occasion the scan was definitely positive. Clinically the tumor showed evidence of increasingly rapid growth. Other gliomas which we have examined with this technic have included ependymoma of the 4th ventricle (Fig. 5), glioma of the optic nerves and chiasm, and glioma of the brain stem. In all cases the scans were positive and localizing.

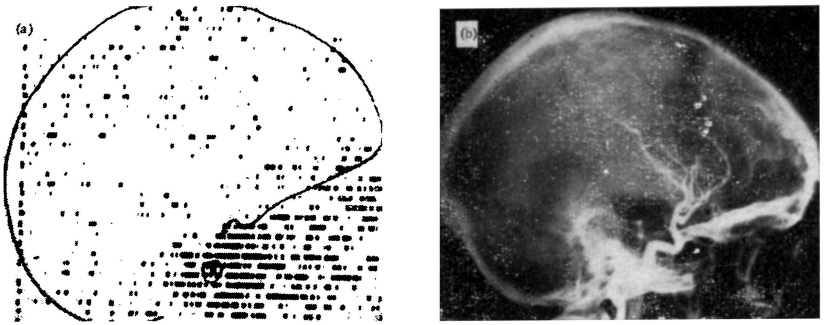

Fig. 4 — Astrocytoma, right temporal: a) the brain scan is completely negative; b) the right brachial cerebral angiogram discloses the presence of a large tumor in the right temporal lobe.

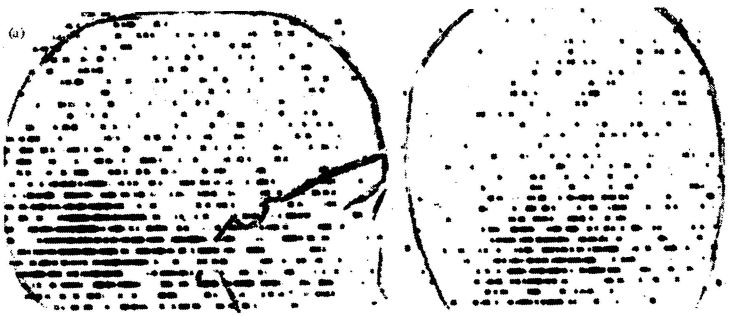

Fig. 5 — Ependymoma, 4th ventricle. This tumor is clearly demonstrated by the brain scan.

Sarcomas of the meninges and lymphosarcomas have given positive results but in one case of meningeal sarcoma the anterior view showed an increased pick-up on one side but the lateral view was not of localizing value. The case of lymphosarcoma was particularly instructive. This 63 year old woman had two lesions, a lymphosarcoma in the right cerebellar hemisphere and another in the pons. She was first seen on another service. The brain scan which they had made was negative. Their study had included a right and left lateral and an anterior scan. No posterior scan had been made. When we saw this lady three months later we had the scan repeated and included a posterior scan. Both the posterior scan and the right lateral disclosed the presence and location of the tumor. There are two possibilities here. Perhaps at the time of the first scan the tumor was not large enough to be shown by this technic. But it is also possible that a posterior scan at that time would have shown the tumor as it did in the later study.

This last case brings up another point which needs emphasis. Tumors in the posterior fossa and at the base of the skull are more difficult to demonstrate with radio-active mercury scanning than are those in the supra-

tentorial fossa away from the base. This is due to the fact that the muscles of mastication and those of the neck, and the mucosa of the nose and para-nasal sinuses tend to pick-up the radio-active mercury as intensively as do intracranial tumors. This concentration of radio-activity at the base of the skull from the material in the muscles and the nasal mucosa tends to obscure tumors which may lie near the base of the skull.

Fifteen patients with metastatic intracranial tumors were examined. In 5 cases the tumors were in the posterior fossa. The scans were positive (Fig. 6) and of localizing value in 3 of these. In 10 cases where the metastatic tumor was in the cerebral hemisphere the scans were diagnostic in 9 of the 10. Radio-active scanning may be of great value in disclosing the unexpected presence of multiple tumors. However, the surgeon should not err in concluding that because the tumors are multiple they are necessarily malignant. As we have noted above multiple benign meningiomas may be similarly demonstrated.

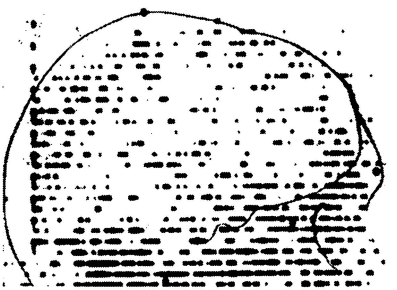

Fig. 6 — Metastatic carcinoma of right cerebellar hemisphere, clearly shown in this lateral radio-active mercury brain scan.

The radio-active mercury scan was definitely positive with one acoustic neurinoma, significant in the lateral scan but not in the posterior one in a second case and not diagnostic in a third.

In two cases of epidermoid cyst of the brain the radio-active scans were negative. It is to be presumed that these very slowly growing, benign, avascular growths which contain cystic cavities filled with large masses of dead desquamated material do not pick-up the radio-active mercury with sufficient intensity to demonstrate their presence. On the other hand intracranial granulomas may be very clearly shown by this technic. Of three cases only one was negative. There was a calcified granuloma in the frontal lobe. In one case, a tuberculoma of the sphenoid ridge and orbital fissure, the radio-active scan was strikingly diagnostic (Fig. 7). Angiography and pneumoencephalography had both failed completely to demonstrate this lesion. The clinical manifestations were typical of a progressive lesion of the orbital fissure.

In addition to the great value of radio-active mercury brain scans in the diagnosis and localization of intracranial tumors and granulomas, this diagnostic technic has other advantages. First, it is safe: various authorities

on the use of radio-active materials have assured us that the technic as used here is without risk to the patient, the physician or the technician who carries out the scan; furthermore, the method is not associated with any complications other than those which might attend any vena-puncture; the risks of arterial occlusion, hemorrhage, cerebral vascular spasm and edema, convulsions, which may be associated with cerebral arteriography are not present in any degree with radio-active scanning; likewise, the risks of various complications associated with pneumoencephalography and ventriculography which are rather considerable, are not at all present here. Second, radio-active scanning is associated with no more discomfort to the patient than that to be expected from a vena-puncture; the discomfort is far, far less than that associated with either cerebral angiography or with air studies. Third, compared with these other diagnostic procedures radio-active mercury brain scanning is relatively inexpensive.

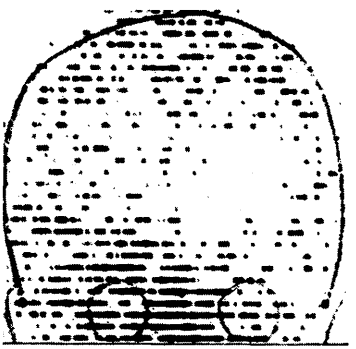

Fig. 7 — Tuberculoma of the right orbital fissure and sphenoid ridge clearly shown in this anterior brain scan. The angiogram and pneumoencephalogram were negative.

The advantages of radio-active mercury brain scanning by their very truth present a not inconsiderable disadvantage. Because the method is cheap, simple, free from great risk or discomfort, and because it can be done by a well trained laboratory technician with little professional supervision, there is the great risk that many physicians untrained in the neurological disciplines will use this technic as a screening device to determine whether their patients are or are not suffering from intracranial space occupying lesions. This technic can not safely be used for this purpose. The well trained neurologist and neurological surgeon is still the best "machine" for the diagnosis of a brain tumor. In fact a physician with adequate neurological training and experience is absolutely essential for that purpose. Radio-active mercury brain scanning is of great value as one of the adjuncts in the study of a patient suspected of harboring a brain tumor. It is not a substitute for a good clinical history, a careful neurological examination and sound clinical judgement. A positive scan is of great significance in indicating the presence of an intra-cranial lesion. A negative scan is of no diagnostic value whatsoever.

It is also noteworthy that those tumors which radio-active mercury scanning is more likely not to disclose are those which are still small and those which are benign. If, therefore, one relies upon radio-active scanning to sort out those patients which are suffering from brain tumor he is likely to over-look just that group which is most likely to benefit from prompt and energetic surgical treatment.

Although certain tumors give positive results in a higher percentage of cases than do others, and although certain tumors, notably the meningiomas, commonly displace a more intense pick-up of the radio-active mercury than do others, it is not possible with any degree of accuracy to make a histological diagnosis as to the type of tumor present, or even to decide that the mass is a neoplasm on the bases of the radio-active scan alone.

SUMMARY

Our experiences with the use of radio-active mercury brain scanning in the diagnosis of a series of intracranial tumors and granulomas have been discussed. It is our belief that this is the most valuable single test available today for demonstrating and localizing an intracranial space occupying lesion. It was proved of value in a high percentage of cases (83.1%). Not all tumors are demonstrable by this method. Glioblastomas and meningiomas gave diagnostic scans in the highest percentage of cases. Astrocytomas may not be demonstrated by this method. Epidermoids have not been shown with this technic in our experience. Tumors in the posterior fossa and at the base of the skull may be obscured by the radio-activity displayed by the muscles and the nasal mucosa at the base of the skull.

The method is safe, is free from discomfort to the patient, is simple to perform and relatively inexpensive. It must not be used by the non-neurologically oriented physician to screen out those patients suffering from brain tumor. Unfortunately the tumors which this technic does not disclose are often the early tumors and those most benign, and thus those most amenable to prompt surgical intervention.

RESUMO

Diagnóstico e localização de tumores intracranianos mediante mapeamento com mercúrio radioativo (Hg^{203}).

Os autores discutem sua experiência com o emprêgo de mercúrio radioativo para o mapeamento de tumores e granulomas intracranianos, concluindo que êste método é atualmente o melhor para demonstrar e localizar lesões expansivas intracranianas, pois seu valor foi demonstrado em 83,1% dos casos. Entretanto nem todos os tumores são demonstráveis por êste método: os glioblastomas e meningeomas forneceram mapas de valor diagnóstico na maioria dos casos; os astrocitomas podem passar despercebidos;

os epidermóides não foram demonstrados. Os tumores da base do crânio e os da fossa posterior podem ser mascarados pela alta capacidade dos músculos do pescoço e das mucosas dos seios paranasais em absorver a substância radioativa.

O método é segúro, de aplicação econômica e não causa desconfôrto ao doente. Êle não deve ser usado por médicos que não estejam orientados no sentido neurológico para o diagnóstico de tumores intracranianos. Infelizmente os tumores que não são evidenciados por êste método são de caráter relativamente benigno e, portanto, os mais suscetíveis de tratamento cirúrgico.

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