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The Utilization of ^{99m}Technetium in Brain Scanning

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The mercurial diuretics, ^{203}Hg and ^{197}Hg chlormerodrin, are, at present, the most widely utilized compounds for scanning of brain lesions. Because of the higher renal dose (40-70 rads/mc) (1) of ^{203}Hg chlormerodrin, we have been routinely scanning with the ^{197}Hg compound. As has been pointed out by others (2), the energy of ^{197}Hg (77 kev) is not an ideal energy for brain scanning, although the renal radiation dose is considerably lower than with ^{203}Hg. The following is a report on 142 patients scanned in a four month period utilizing ^{99m}Tc as a brain scanning agent.

PHYSICAL PROPERTIES

The ^{99m}Tc is obtained from a ^{99}Mo-Tc generator.[4] The parent, ^{99}Mo, decays with a half life of 67 hours to produce a short lived daughter product, ^{99m}Tc (half life of 6 hours). The metastable ^{99m}Tc decays to ^{99}Tc with a gamma emission of approximately 140 kev (3). ^{99m}Tc has a $\Gamma = 0.7$ r/mc-hr at 1 cm (4) (when its low energy characteristic x-rays are also included).

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TECHNIQUE

The short lived ^{99m}Tc is obtained from the generator by pouring 15-25 ml of 0.1M HNO_3 or HCl into the top of the generator and collecting the product solution as it drips from the bottom. The material is then calibrated with an ionization chamber. The yield of ^{99m}Tc has been equal to approximately 65 per cent of the initial activity corrected for decay to the day in question (utilizing 20 ml of 0.IM HCl) as seen in the Table. We have found that approximately half the morning yield can be obtained in about 5-6 hours with little effect on the yield the following day.

The ^{99m}Tc is administered orally (the patient being in a fasting state for at least 6 hours) and combined with isotonic saline solution. The patients are asked to walk for approximately 30 minutes (those not ambulatory are requested to lie on their right sides) to assist gastric emptying. Our routine dose for brain scanning is 10 mc.[1]

Scanning is routinely begun in 30-45 minutes. With our Picker Magna-scanner (3 × 2 inch crystal) and the 19-hole collimator, we routinely obtain 7-10,000 cpm. The following settings are used with this count rate range: window

[1]Harper *et al* (5) have estimated the whole body dose from 10 mc of ^{99m}Tc at about 0.2 rads. The ^{99m}Tc is specifically trapped by the thyroid gland, salivary glands, and the gastric mucosa. Thus the dose to these organs may be somewhat higher than that of the whole body (with the half life of 6 hours the radiation dose to these organs would still be quite low).

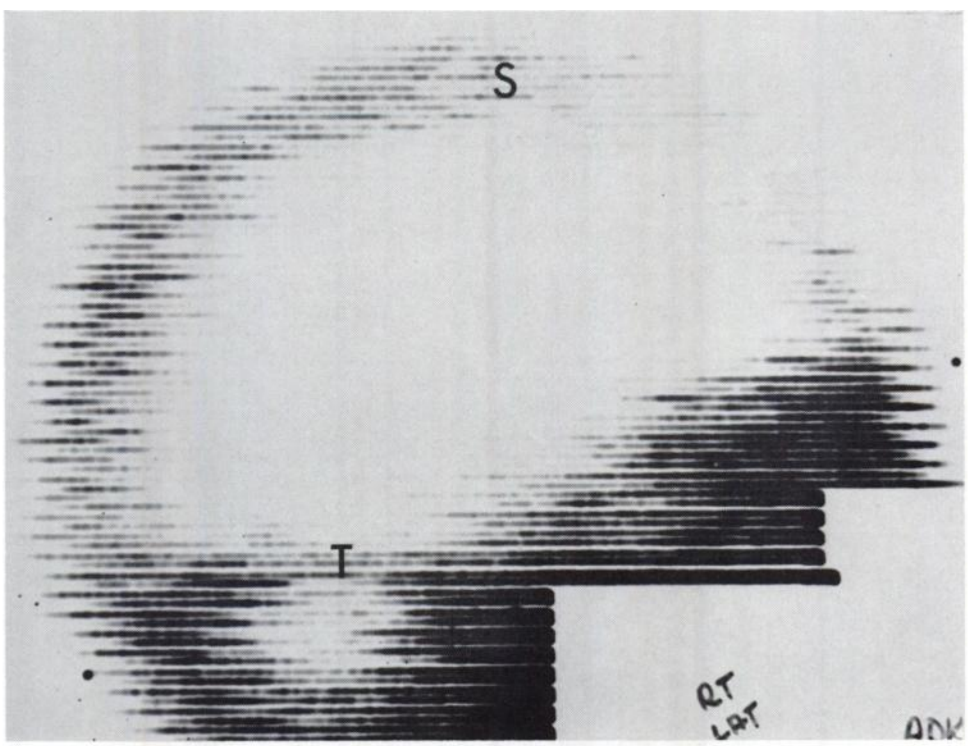

Fig. 1. (A) lateral

of 130-160 kev, scan speed of 50-60 cm/min and a line spacing of 0.25 cm with a small photodot. We routinely obtain both laterals and either an anterior or posterior view depending on the findings from the laterals or clinical impressions. This requires approximately 1½ hours scanning time.

CLINICAL MATERIAL

Normal ^{99m}Tc brain scans in three projections are shown in Figs. 1A, B and C. Blood containing spaces such as the superior sagittal and transverse sinuses

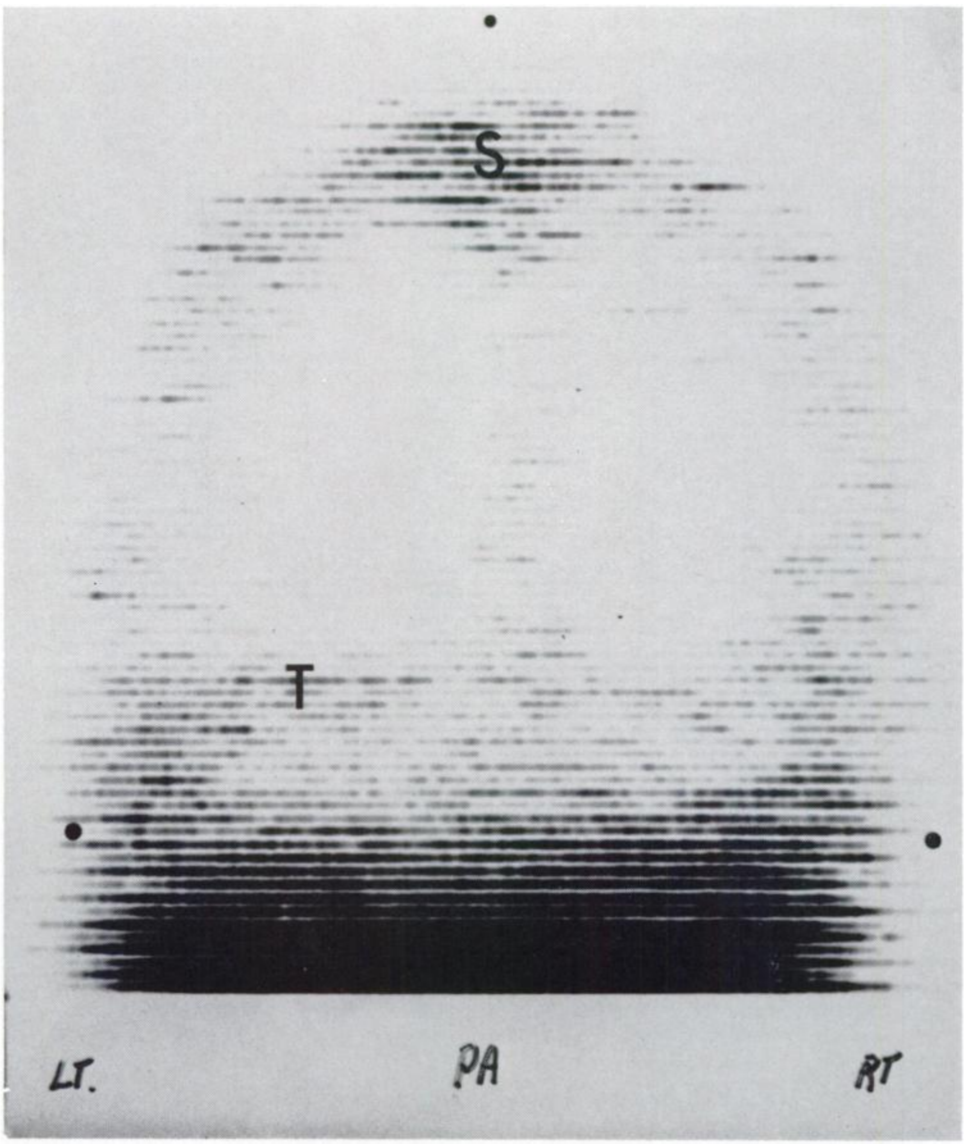

Fig. 1. (B) posterior

are sharply defined. The posterior fossa is visualized on the lateral and posterior projections with reference to the transverse sinuses (T). Abnormal areas are visualized by increased concentration of ^{99m}Tc.

In the 142 patients scanned with ^{99m}Tc, there were 24 abnormal scans. Of these 24 abnormal scans, 12 have been verified by pathologic diagnosis, 7 vascular abnormalities were verified by arteriography and the remaining 5 correlate well with the clinical impression. Of the remaining 118 scans interpreted as normal, 3 have subsequently been proven to be false negatives (pituitary tumor, lipoma of the corpus callosum and cerebellar metastases from a lung adenocarcinoma). Since we have been using ^{99m}Tc for such a short period of time, final evaluation of the remaining "negative" scans would not be appropriate.

The ^{99m}Tc adequately visualized the following conditions: six malignant gliomas (Figs. 2A, B), two meningiomas (Figs. 3, 4), four arteriovenous mal-

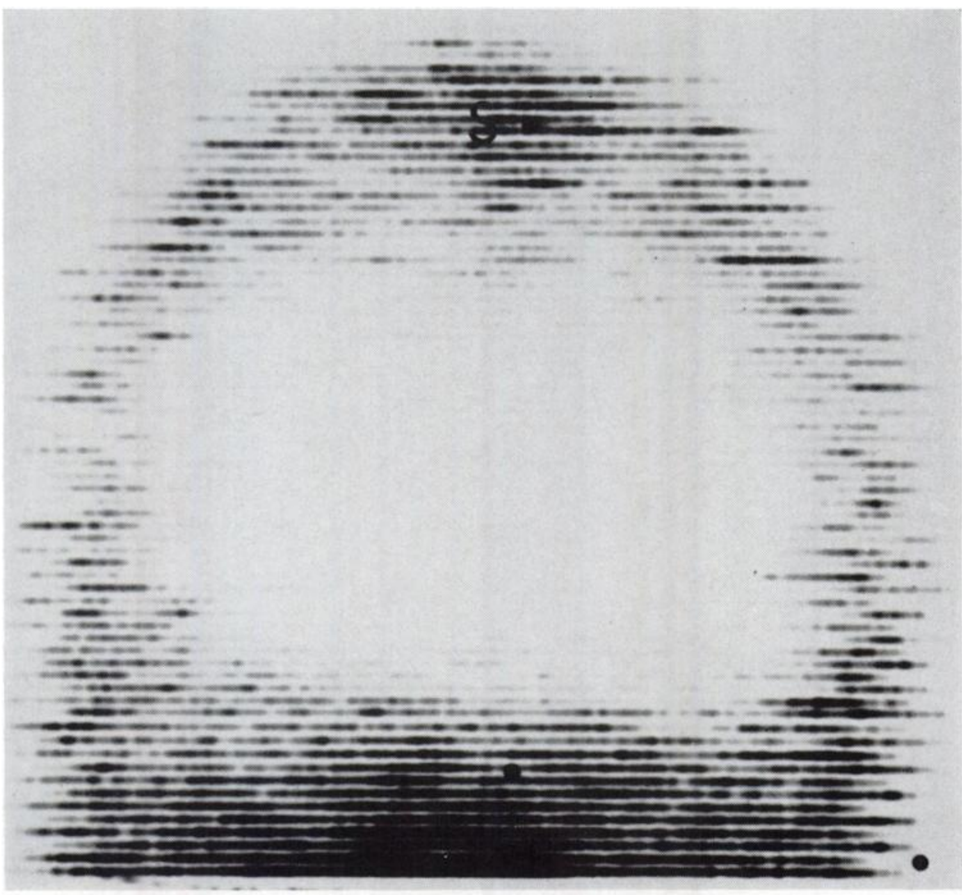

Fig. 1. (C) anterior

Fig. 1A, 1B, and 1C. Normal ^{99m}Tc brain scans. Blood-containing spaces are sharply delineated: superior sagittal sinus (S) and transverse sinus (T). Normal scan may show slightly increased concentration in area of choroid plexus.

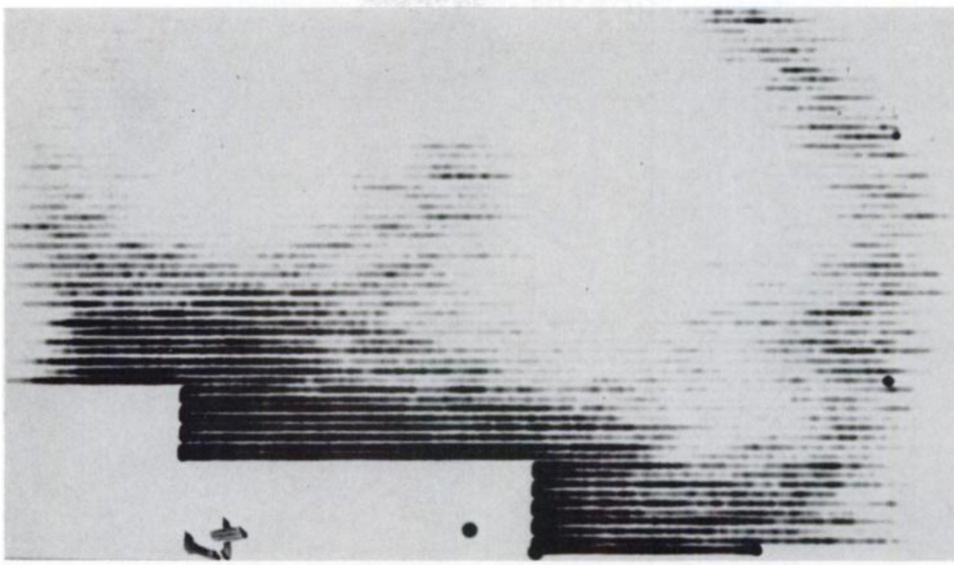

Fig. 2A

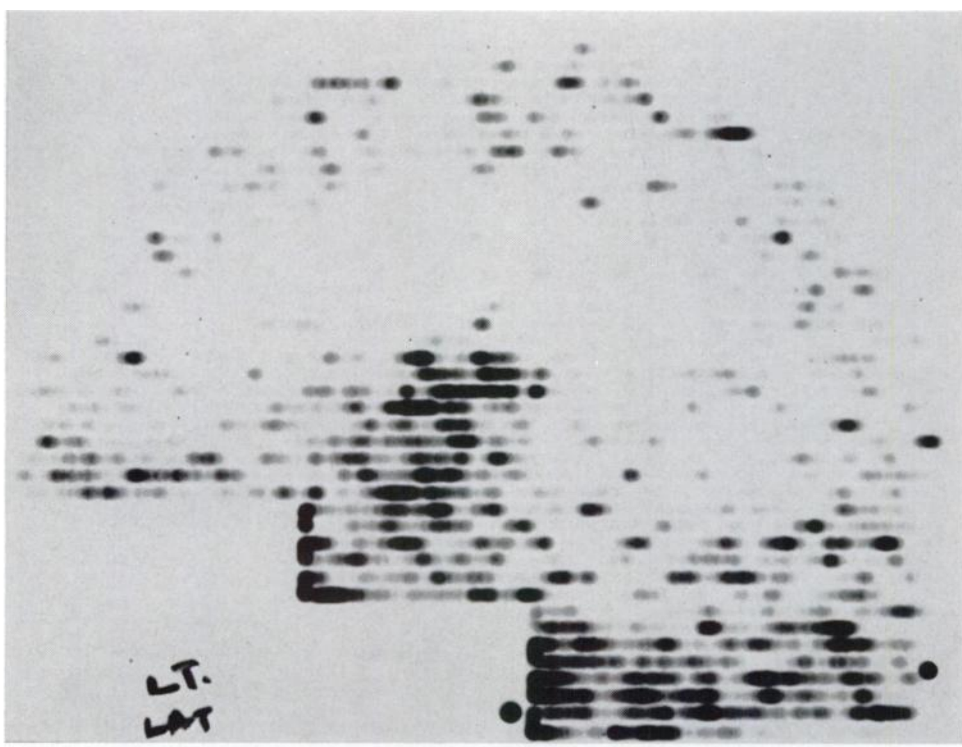

Fig. 2B

Fig. 2A and 2B. Left lateral scans of a malignant glioma using different radioisotopes. (A) ^{99m}Tc and (B) ^{197}Hg chlormerodrin.

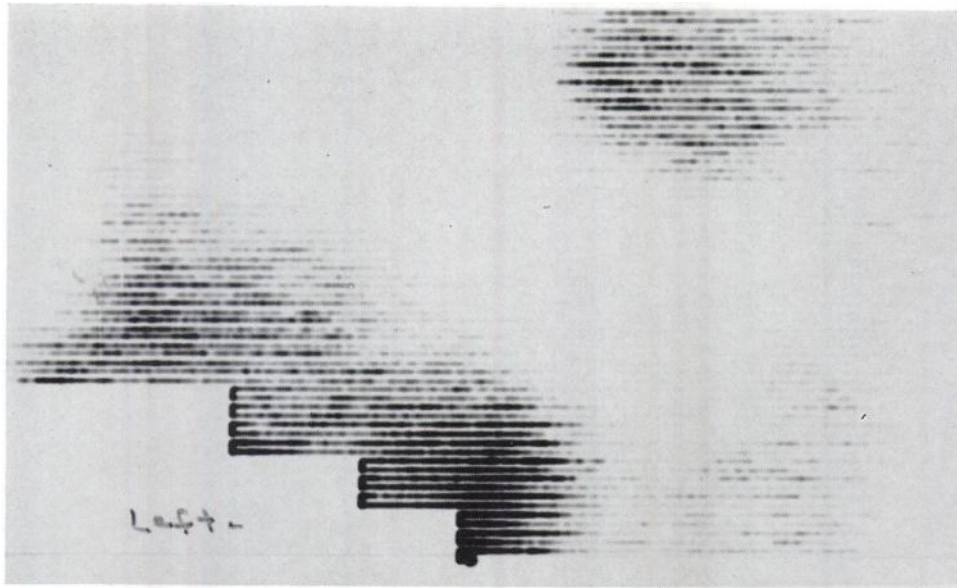

Fig. 3A

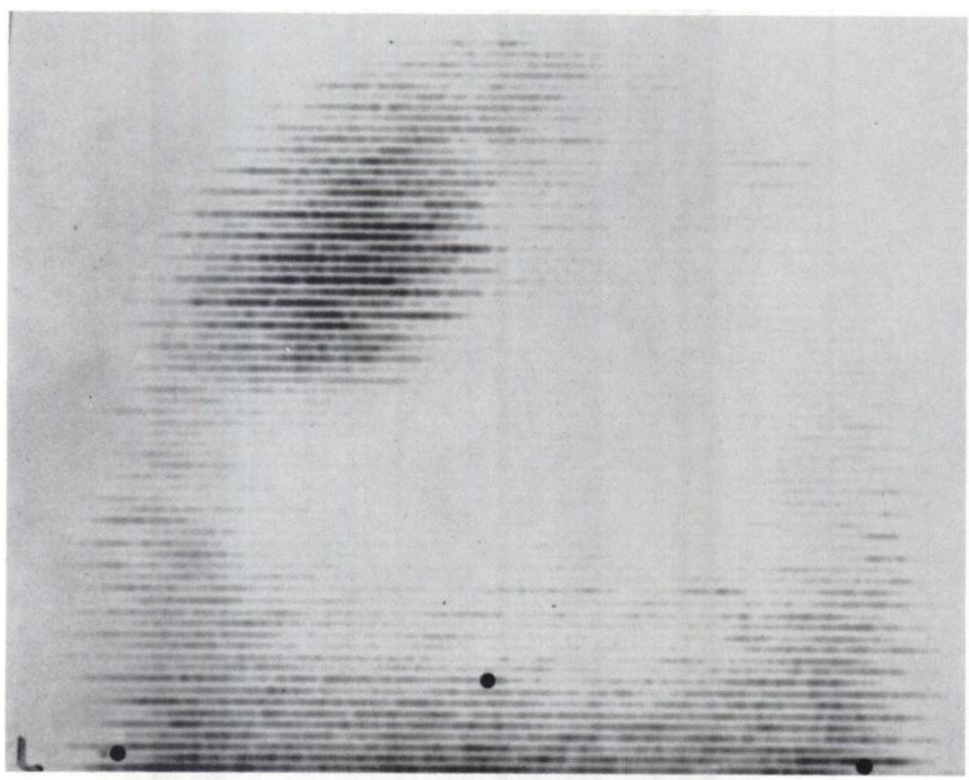

Fig. 3B

Fig. 3A and 3B. Meningioma (A) lateral and (B) posterior.

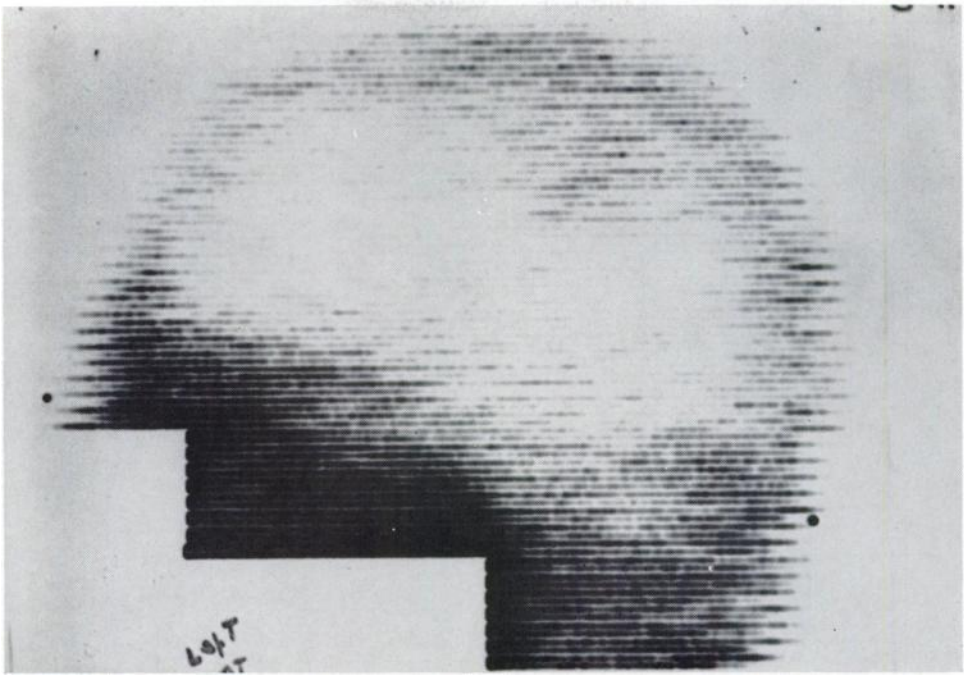

Fig. 4A

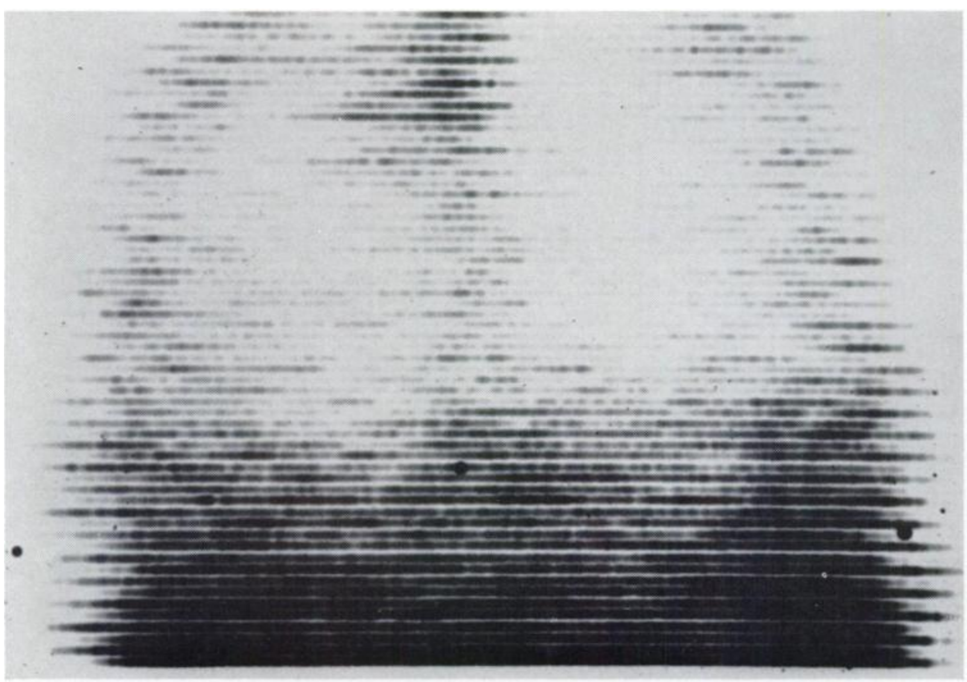

Fig. 4A and 4B. Large parasaggital meningioma. (A) left lateral and (B) posterior.

formations (Fig. 5), two cerebral metastasis (Fig. 6), a brain abscess, an acoustic neuroma, and three cerebral infarcts. Twelve abnormal cases were repeated with ^{197}Hg chloromerodrin (Fig. 2B). In each instance both compounds adequately demonstrated the abnormalities.

Percentage yield per day on the basis of initial Brookhaven National Laboratory Calibration (if initial strength of the ^{99m}Tc in generator is 100 mc, these values would represent millicuries).

Days	*Percentage yield*
0	65
1	52
2	42
3	33
4	26
5	21

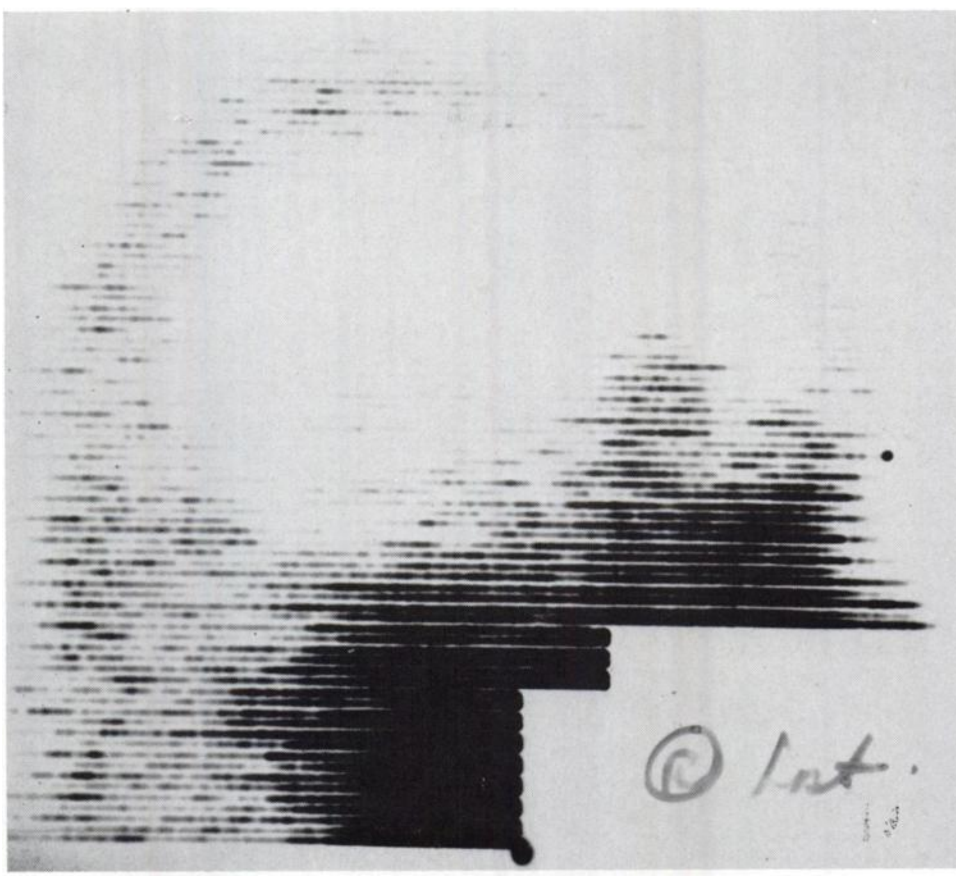

Fig. 5. Arteriovenous malformation.

DISCUSSION

In our experience with 142 ^{99m}Tc brain scans, the advantages of this radioisotope seem to far outweigh its disadvantages. ^{99m}Tc has the following advantages when compared to other radiopharmaceuticals currently used in brain scanning:

(1) May be administered orally.
(2) Optimum brain scanning energy of 140 kev.
(3) High count rates and high scanning speeds with relatively low patient radiation dose.
(4) Scanning may be begun within ½ hour, even after oral administration.
(5) Relatively low cost.
(6) Adequate delineation and visualization of brain lesions.

However, some of the disadvantages should be pointed out:

(1) Must "milk" the generator at least daily (requires 20 minutes).
(2) Three of 142 patients did not absorb an adequate amount of orally administered ^{99m}Tc (scan count rates less than 2000 cpm).
(3) Patient must be in a fasting state.
(4) Rapid decay of ^{99m}Tc does not permit shelf storage.
(5) Possible extracranial contamination from saliva producing artefacts.

In our experience, with the higher count-rates associated with ^{99m}Tc brain scanning, the technician is able to obtain technically satisfactory scans more consistently than with ^{197}Hg (in the dosage range normally employed).

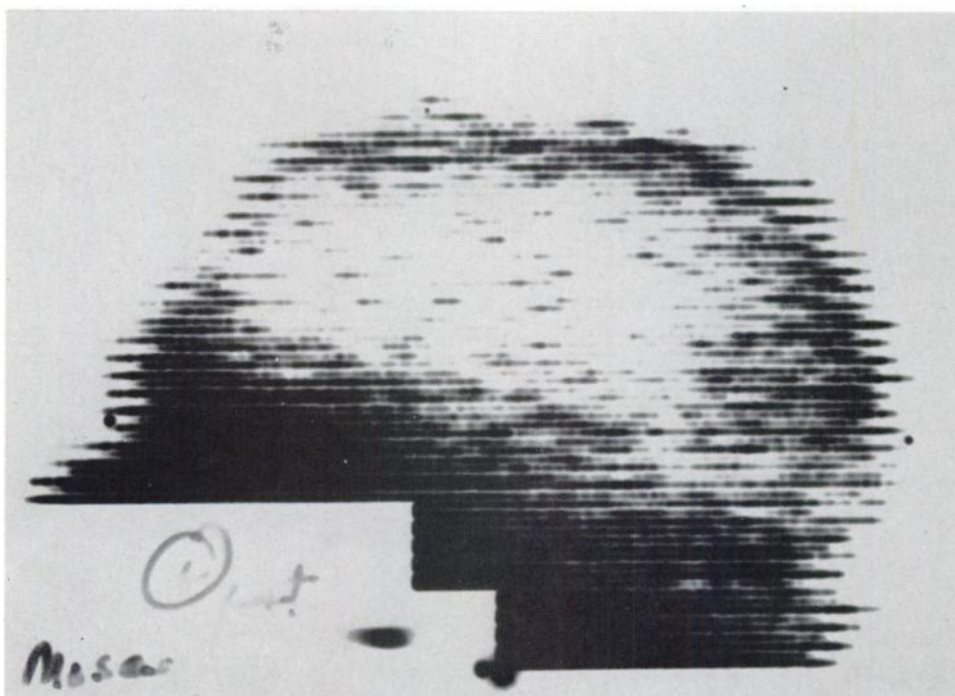

Fig. 6. Cerebral metastasis from a carcinoma of the prostate.

SUMMARY

The clinical usefulness of ^{99m}Tc in brain scanning is discussed. In this series of 142 patients, examples of positive scans are presented in patients with known pathology. Comparison is made to other brain scanning agents currently being utilized.

ACKNOWLEDGEMENTS

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