LOCALIZATION OF INTRACRANIAL VASCULAR LESIONS BY RADIOACTIVE ISOTOPES AND AN AUTOMATIC CONTOUR BRAIN SCANNER*

WILLIAM FEINDEL, M.D., RICHARD LEE ROVIT, M.D., AND LLOYD STEPHENS-NEWSHAM, PH.D.

Department of Neurology and Neurosurgery, McGill University and The Montreal Neurological Institute, Montreal, Canada

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DURING the past ten years, more than 100 reports in the neurosurgical and nucleonic literature have indicated that radioactive isotopes can provide a useful, painless and safe method for the detection and localization of certain intracranial lesions. Most authors have agreed that meningiomas, malignant gliomas, and metastatic neoplasms are readily and sometimes strikingly detected. The degree of success obtained in localizing other types of tumour and a wide variety of non-neoplastic lesions has varied considerably among these reports. In this area, it appears that the use of an appropriate radioactive substance, a satisfactory technique for scanning the head, as well as suitable devices for discriminating and computing the resulting radiation, may make all the difference between success and failure.5,15,21

The reports, for example, on the localization of subdural haematomas by the isotope method will serve to indicate this variability. Using diiodofluorescein Moore13 found an increased concentration in one case of subdural haematoma, although the material removed at operation proved to contain very little of the radioisotope, and he suggested that the increased rate of count over the side of the subdural haematoma might be ascribable to edema of the brain. With the same isotope Peyton and others14 also detected subdural haematomas, but Ashkenazy et al.1 in 8 subdural haematomas found little or no evidence of localization.

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The results using radioactive iodinated serum albumin (RISA) were reported highly satisfactory by Dunbar and Ray7 who were able to localize subdural haematoma by this method in 4 cases. Since they found that the subdural fluid has less radioactivity than venous blood they assumed that localization was related to the radioisotope being concentrated in the brain beneath the region of the subdural clot. In 1 case of bilateral subdural haematoma, Rhody and Nowlis17 were unable to get any localization by RISA.

Sweet and his co-workers5,12,22 reported that they were able to detect 7 out of 8 subdural haematomas using arsenic 74, but that no positive scans were obtained in 3 subdural haematomas using copper 64. In a chronic subdural haematoma of about 3 months' duration and 5 days following the injection of arsenic, they noticed a somewhat higher concentration in the membrane of the haematoma as compared to the clot. Planiol,15 using RISA and a careful technique of manual scanning with repeated scans at 1 hour and 24 hours, was able to localize subdural haematoma in 2 cases.

The reports concerning other types of cerebral vascular lesions, such as those resulting from thrombosis or intracerebral haemorrhage, are even more variable. It seems difficult to evaluate the usefulness of techniques of radioactive scanning in this field at the present time. In addition to the points outlined above, the difficulty in evaluating the isotope technique in terms of its clinical use is also dependent upon the fact that the complex processes underlying
The differential uptake of radioactive substances, associated with certain intracranial lesions, require much further study. Evidence so far indicates that significant factors include: (1) increased permeability of the "blood-brain barrier" in and about the lesion,\(^5,11,18\) and (2) increased vascularity of the lesion as compared to the surrounding normal brain tissue.\(^6,8,15,19,21\) A third factor, metabolic uptake by the pathological tissue, may also be of considerable importance, particularly in actively growing lesions.

The present report will illustrate with selected cases that increased vascularity is a prominent feature of many intracranial lesions that are detected most readily and localized by the radioisotope method.

These studies were made with an automatic contour brain-scanning device that makes it possible to obtain reproducible scan records of the total and differential concentration of isotope in the head. By using human serum albumin tagged with radioactive iodine 131 (RISA) it was also possible to exploit the selective permeability of normal brain tissue to albumin, as well as the retention of RISA in the circulation for a biological half-life of 4 days which allows for repeated scans to be carried out.

Since the automatic contour scanner differs from the more familiar rectilinear scanning devices described by Sweet and Brownell\(^21\) and by Shy et al.,\(^20\) a brief account of the principles will be given. The application of these principles to the localization of intracranial lesions will be evident from the examples described in the case reports. Details of design have been described by Reid and Johns\(^16\) and by Johns and Cederglund.\(^19\) The clinical evaluation of the method in a group of 281 patients with a variety of intracranial lesions has been reported previously.\(^6,9\) On the basis of assessment of the scans in 115 cases, which were verified as to the presence of intracranial lesions, good or excellent correlation was obtained in 90 per cent with failure of localization in the remaining 10 per cent.

Using the contour scanner and RISA, we have found that chronic subdural haematomas are distinguished by a characteristic pattern of radioactive uptake. The radioactivity of the fluid in the haematoma, as compared to that of peripheral blood, has proved to be surprisingly high.

Inert collections of blood within the cranium are associated with lower levels of activity.

Highly vascular lesions, such as arteriovenous malformation and vascular tumours, show the most intense concentration of RISA. This reaches a high peak immediately after injection and is maintained over a period of several days until the level of RISA in the circulating blood drops off.

These findings will be amplified by selected case reports.

**METHOD OF CONTOUR SCANNING**

The device utilizes twin scintillation detectors which scan each side of the head in a series of concentric arcs beginning in the parasagittal region (Figs. 1 and 2). The thyroid gland is blocked by Lugol's iodine solution 24 hours before the injection of 300–400 microcuries of RISA. The actual scan takes 30 minutes. Repeated scans may be carried out up to as long as 1 week on the basis of the single injection.

Some of the advantages of the contour

![Fig. 1. Contour brain scanner. (A) Brain scintillation detectors placed at starting position for the scan. (B) Remote-control push-button pedal for manual operation of scanner during positioning of patient. (C) Scan chart on which four metal stampers register counts. (D) Motor control, scaler and computer unit.](image-url)