The Value of Postoperative Brain Scan in Patients with Supratentorial Intracranial Tumors*

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If a brain tumor recurs after a primary resection, as most gliomas do, the recurrence probably has started before the patient leaves the operating room. During the ensuing months and years, the recurrent neoplasm grows and eventually produces seizures, headaches, or other symptoms and signs that indicate its presence. However, some of the same symptoms and signs can be produced by postoperative gliosis, fibrosis, hydrocephalus, and vascular insufficiency, and the diagnosis of significant tumor recurrence may be difficult to establish by history and physical examination in the early stages. Because of these processes and the mechanical distortions produced by the operation, electroencephalography, echoencephalography, and plain roentgenography may also be of little value.

Until recently, the clinician evaluating the initial evidences of recurrence has been faced with the choice of waiting for further manifestations or of subjecting his patient to the expense and inconvenience of hospitalization and to the discomfort and risks of angiography, pneumoencephalography, or ventriculography. Further delay is perhaps of little importance in patients with malignant gliomas, but in patients with benign tumors it may result in significant neurological damage that could have been prevented.

This situation has been improved greatly by the development of two new diagnostic procedures. The first employs tantalum powder, which is sprinkled along the zone of resection at the conclusion of the primary tumor removal. The subsequent displacement of this tantalum powder by the enlarging neoplasm then can be demonstrated roentgenographically. The second procedure is isotope encephalography, which heretofore has been used mainly for preoperative localization of intracranial neoplasms, although it also has been used in evaluating patients whose tumors have been treated by radiotherapy. In 1953, Ashkenazy proposed that isotope encephalography be used to identify the recurrences of brain tumors after primary resections, and this idea has been mentioned by others since. However, relatively few studies of postoperative brain scans have been published, and in none has there been a detailed analysis of the patterns of postoperative isotope retention. At the beginning of our own experience with postoperative brain scans we worried that superficial retention of isotope in the scalp and skull might mask underlying tumor recurrences and that further confusion might arise from isotope retention in deeper areas of fibrosis and gliosis. The present study was undertaken to analyze these and the other problems of interpretation mentioned below.

Material and Method

Seventy-three patients had 83 brain scans at various times after surgery. Of these, 20 patients also had preoperative scans. Commercial rectilinear scanners, with a 3- or 5-inch scintillation crystal and a coarse 3-inch focusing collimator, were used for all examinations. For the postoperative scans, various agents were given intravenously or orally; two scans were performed at 24 and 48 hours after the injection of I labeled human serum albumin, nine at 1 to 3 hours after the injection of Hg labeled neohydrin, 12 at 1 to 3 hours after the injection of Hg labeled neohydrin, and 60 at 30 to 90 minutes after the injection or ingestion of Tc as pertechnetate. From two to four views (anteroposterior, posteroanterior, left lateral, and right lateral) were obtained at each examination. Roentgenograms of the skull...
made either in the scanning position immediately before the brain scan or at other times in the Department of Radiology were used for rough estimates of the sizes and locations of craniectomy and craniotomy defects. However, because of magnification, these films could not be superimposed exactly on the brain scans for accurate analysis.

The retention in all postoperative scans was classified as superficial (within or adjacent to the calvarium) or deep, after comparison of the sagittal and coronal views. In each case, further classification was achieved by relating the areas of superficial isotope retention to the operative defect in the skull. In addition, the intensity of abnormal retention in each view was arbitrarily estimated as 1+ to 3+. These data were then correlated with similar data from the preoperative scans and with the following clinical parameters: location of original lesion, operative approach, pathological diagnosis, extent of resection, type of closure, radiotherapy, postoperative infection, chronological relation of scan to operation, and clinical or pathological evidence of residual or recurrent tumor at the time of brain scan. The sharpest definition of the retention patterns was obtained with technetium$^{99m}$.

**Superficial Retention**

The various patterns of superficial postoperative isotope retention were best demonstrated in the patients with non-neoplastic lesions. The four patients with chronic subdural hematoma or subdural empyema had postoperative patterns of superficial retention similar to their preoperative patterns, which consisted of diffuse retention on the lateral scan and crescent-shaped superficial retention on the anteroposterior and postero-anterior scans.$^{3,8}$ The following case is illustrative.

Case 1. E. C., a 60-year-old woman under treatment with warfarin sodium for a pulmonary embolus, fell and later gradually developed confusion and lethargy. On December 15, 1965, a brain scan (Tc$^{99m}$) showed superficial retention compatible with a left subdural hematoma, and this was confirmed by carotid arteriography and left temporal craniectomy. Hematoma membranes were found at operation. Tantalum dust was placed on the cortical surface and tantalum clips on the dura mater.$^{12}$ Plain roentgenograms on January 21, 1966, showed the tantalum dust closer to the dural clips than previously. A second brain scan (Tc$^{99m}$) on January 29, 1966, again showed isotope retention in a crescent-shaped superficial pattern. When last examined on July 5, 1966, 7 months postoperatively, the patient was doing well and had no evidence of recurrent subdural hematoma. Plain roentgenograms showed the tantalum dust immediately adjacent to the dural clips, and a third brain scan (Tc$^{99m}$) still showed residual superficial retention, though less marked than previously (Fig. 1).

A second pattern of superficial retention was observed in 16 scans. In these scans the abnormal isotope retention occurred in a fairly uniform distribution within the area of the craniectomy or craniotomy defect. The following case demonstrates this type of uniform superficial retention.

Case 2. J. W., a 45-year-old man, sustained a blow to the left temporoparietal area on August 15, 1964, resulting in a depressed skull fracture, dysphasia, and seizures. A brain scan (Hg$^{197}$) was performed on August.

![Fig. 1. Case 1. Anteroposterior brain scan with Tc$^{99m}$ 7 months after the evacuation of a chronic subdural hematoma from the surface of the left hemisphere. Crescent-shaped abnormal superficial retention is still present on the left, despite absence of a residual hematoma by other criteria.](image-url)