Computerized Transaxial Tomography and Cerebral Serial Scintigraphy in Intracranial Tumors—Rates of Detection and Tumor-Type Identification: Concise Communication

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In 215 cases of intracranial tumors with subsequent histological identification, computerized transaxial tomography (CTT), and cerebral serial scintigraphy (CSS) with [^{99m}Tc] pertechnetate were carried out to compare the efficiency of each method in detecting and classifying such tumors. With a tumor detection rate of 99%, CTT turned out to be superior to CSS (91%). On the other hand, CSS findings enhanced the CTT rate of correctly identified tumor types in meningiomas from 85 to 92% and in high-grade gliomas from 82 to 89%. In metastases, low-grade gliomas, and various other tumors, CSS supported CTT by confirming a number of these tumor types. Therefore, the most important use of CSS in intracranial tumors today is its role as a supplement to CTT in order to establish and confirm type-specific diagnoses.

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Computerized transaxial tomography (CTT), introduced by Hounsfield (*1*), has proved to be an effective noninvasive method for examining intracranial structures and detecting space-occupying lesions. In the detection of intracranial tumors, CTT was reported recently to fail in only 1.3% (*2*). On the other hand, identification of tumor type turned out to be difficult with CTT (*2–5*).

Radionuclide brain imaging, performed as serial scintigraphy, proved to be effective in establishing type-specific tumor patterns (*6–11*). Cerebral serial scintigraphy (CSS) includes radionuclide angiography (*12–14*), early and late static imaging.

The present study was undertaken to compare CTT findings with the results obtained from CSS in 215 cases of intracranial tumors with histological identification, in order to evaluate the efficiency of each method (a) in establishing the diagnosis "tumor," and (b) in identifying tumor types.

MATERIALS AND METHODS

Two hundred and four patients with 215 intracranial tumors were examined with both CTT and CSS between September 1974 and April 1977. Of these tumors, 180 (83.7%) were located in the supratentorial space and adjacent to the base of the anterior and middle fossae. Only 35 neoplasms (16.3%) were found in the posterior fossa.

Diagnosis of tumor type was made by each team independently before any invasive procedure, taking into account the patient's history and clinical findings. Histologic diagnoses were available in all cases and are listed in the tables. Gliomas were classified according to Ringertz's system (grades 1–3).

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TABLE 1. RATES OF CORRECT TUMOR DETECTION BY CTT AND CEREBRAL SERIAL SCINTIGRAPHY (CSS)

	N	CTT	CSS
Meningiomas	74	73 (99%)	71 (96%)
High-grade gliomas	45	45 (100%)	45 (100%)
Low-grade gliomas*	10	10 (100%)	6 (60%)
Low-grade gliomas†	20	20 (100%)	18 (90%)
Metastases	27	27 (100%)	22 (81%)
Other tumors	39	38 (97%)	33 (85%)
Total	215	213 (99%)	195 (91%)
Number of patients	204	202 (99%)	189 (93%)

* Grade 1.
† Grade 2.

CTT was performed with a head scanner using the standard technique (*15*). The image display consisted of a 160 × 160 matrix. Contrast enhancement was obtained in all patients by i.v. injection of 1 ml of 60% sodium diatrizoate per kg body weight after unenhanced ("plain") scanning. CTT patterns were evaluated according to the criteria established in 1975 by Kazner et al. (*15*) and confirmed in the German multicenter study of 1304 intracranial tumors, published by Wende et al. (*2*).

CSS was performed in three steps, commencing with radionuclide angiography, using a wide-field gamma camera. After a blocking dose of 300 mg of potassium perchlorate, 10 mCi of [^{99m}Tc] pertechnetate were given intravenously in rapid bolus fashion. Using anterior or posterior projection, data were obtained both from Polaroid images (3 sec per image) and from an on-line computer system. Static imaging was performed 3–10 min after injection in at least three projections, and 60–80 min after injection in at least four projections (AP, PA, left and right lateral). In selected cases, images were also recorded 2–3 hr after injection. CSS findings were evaluated according to the criteria published by Rösler and coworkers (*6–9,12*) and to our own experience (*10,11,16*).

RESULTS

Table 1 summarizes the results of CTT and CSS with respect to tumor detection, i.e. how frequently an abnormal finding was definitely interpreted as being caused by a tumor. The total number of patients (204) was smaller than the number of tumors (215) because of 27 metastases in 16 patients. CTT failed to identify an abnormal pattern as tumor in only 1% of the cases. CSS gave 9% false negatives, including seven tumors, located in or close to the base of the calvarium (three meningiomas, two low-grade gliomas, and three other tumors). Metastases not detected by CSS (n = 5) measured less than 1 cm in diameter. There was no significant difference in detection rate between supratentorial and infratentorial tumors. The latter formed the majority (30 cases, or 77%) of the group listed as "other tumors."

Table 2 presents data on rates of correct tumor-type identification. Since both methods proved unsuitable for reliable differentiation between a grade 2 glioma and a metastasis, a bivalent subgroup has been introduced for such cases. The highest rates of correct tumor-type identification were obtained through combined evaluation (CTT and CSS), especially in meningiomas (92%) and in high-grade gliomas (89%). In these groups, the two methods gave similar percentages of correct diagnoses, ranging from 80% to 86%. With metastases, low-grade gliomas, and various other tumors, CTT was evidently superior. In these cases the value of CSS as a supplement to CTT was therefore limited to two cases only.

DISCUSSION

CTT reflects brain structures and their alterations (*3–5,15,17*). Therefore, in the present study, CTT was found to be more effective in detecting intracranial tumors than CSS. The CSS rate of 91% agrees well with the results published by other authors (*7,9*). Given a larger proportion of posterior-fossa tumors, a higher failure of CTT and CSS might be expected. The present and other series (*18*) are not representative, however, because of the small number of posterior-fossa tumors examined. Nevertheless, the rate of tumor detection by CTT (99%, Table 1) hardly needs to be augmented by employment of CSS, as it has been necessary when CTT rates were considerably lower (*19*).

Criteria for tumor-type identification with both CTT and CSS are based in part on contrast enhance-

TABLE 2. RATES OF CORRECT TUMOR-TYPE IDENTIFICATION BY CTT AND CEREBRAL SERIAL SCINTIGRAPHY (CSS)

	N	CTT	CSS	CTT and CSS
Meningiomas	74	63 (85%)	64 (86%)	68 (92%)
High-grade gliomas	45	37 (82%)	36 (80%)	40 (89%)
Low-grade gliomas	30	17 (57%)	13 (43%)	18 (60%)
Subgroup*		5 (17%)	7 (23%)	
Metastases	27	23 (85%)	17 (63%)	23 (85%)
Subgroup*		1 (4%)	4 (15%)	
Other tumors	39	17 (43%)	7 (18%)	18 (46%)

* Represents two tumor types: either grade-2 glioma or metastasis.

ment in CTT or on the intracranial accumulation of pertechnetate in CSS. From Gado et al. (*20,21*) we know that the mechanisms producing these effects are very similar. In CTT, tumor patterns in the plain scan, as well as after contrast enhancement, are relevant factors in tumor-type diagnosis (*2–5,15,17*). In CSS, classification is achieved by evaluating intracranial distribution and accumulation of pertechnetate, based upon time of onset and time rate of development (*6–14*). These data consequently include the findings obtained from radionuclide angiography, which as yet has no correlate in CTT. CSS thus complements the more static reflections of CTT, and combined evaluation of all data obtained from both CTT and CSS has led to a higher rate of correct identification of tumor types than could be achieved by either method alone (Table 2).

Despite this role of CSS as a supplement to CTT, there still remain problems not solved by this combination. Such problems are the differentiation of grade-2 gliomas from single metastases, and of certain high-grade gliomas from brain abscesses. In cerebral infarctions, we have experienced few problems in establishing a correct diagnosis (*16*).

On the basis of our findings (Table 1, *16*), we consider it desirable to submit all neurological patients to primary CTT examination. Since our CTT department does not have adequate capacity, primary CSS screening is still done in about 50 patients per week. If CSS is normal, the use of CTT depends on the outcome of the clinical conference. If CSS completely explains the patient's neurological problems, it is not mandatory to employ CTT (*22*), unless a neurosurgical intervention is planned. CSS need not be performed if CTT and other findings have established an unequivocal diagnosis.

We think that CSS should be done, supplementary to CTT, in all cases where tumor-type diagnosis is questionable or unobtainable by CTT. If a cerebrovascular disease without tissue-density changes is assumed, radionuclide angiography should be used according to its complementary role (*16,22*).

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