Grade II Astrocytoma Visualized by Technetium-99m-ECD SPECT

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We present a case of primary brain tumor demonstrating increased uptake of ^{99m}Tc-ECD. Astrocytoma (Grade II) showed significantly increased cerebral blood perfusion on dynamic images and homogeneously increased uptake on static images with ^{99m}Tc-ECD brain SPECT. There seems to be some difference in perfusion and mechanism of tumor uptake among the cerebral blood flow imaging agents (^{99m}Tc-ECD, ^{99m}Tc-HMPAO and [^{123}I]-IMP) and ^{201}Tl-chloride.

Key Words: technetium-99m-ECD; thallium-201-chloride; astrocytoma; brain tumor; SPECT

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Technetium-99m-ethyl cysteinate dimer (^{99m}Tc-ECD) has been developed for cerebral blood flow (CBF) imaging and is available for clinical use. It is a lipophilic chelating agent that can penetrate the normal blood-brain barrier (BBB); it then accumulates in brain parenchymal tissue in proportion to the CBF and persists stably for long time by rapid de-esterification to a polar metabolite that cannot recross the BBB. Other CBF imaging agents, such as ^{123}I-N-isopropyl-p-iodoamphetamine (^{123}I-IMP) and ^{99m}Tc-hexamethyl-propyleneamine oxime (^{99m}Tc-HMPAO), have been in clinical use for years. Although these agents usually show a defect or decreased uptake in most brain tumors, increased accumulation has been reported in some of them, mostly hypervascular tumors, such as meningioma, high-grade astrocytoma or glioblastoma.

CASE REPORT

A 24-yr-old man complained of headache for the last 7 mo. He recently developed a severe headache and an ophthalmologist detected a choked disc. MRI revealed a large tumor in the right frontal lobe of the brain with inhomogeneous enhancement, with less enhancement in the anterior and medial portion of the tumor (Fig. 1). Brain CT demonstrated peripheral calcification in the tumor (Fig. 2A) and inhomogeneous contrast enhancement (Fig. 2B).

Brain SPECT study was performed to evaluate blood perfusion and tumor malignancy after intravenous administration of approximately 600 MBq ^{99m}Tc-ECD and 111 MBq ^{201}Tl-chloride, using a ring-type SPECT scanner dedicated for brain studies.

Dynamic and static images were obtained 1 min per frame and approximately 5 min per frame, respectively, in the ^{99m}Tc-ECD study, and 1 min per frame and approximately 20 min per frame for the ^{201}Tl-Cl study. Tumor-to-background ratios (T/B ratio) were calculated to draw regions of interest (ROIs) over the tumor and contralateral normal brain tissue and obtain maximum and average counts, respectively. We decided to normalize the maximum counts of the tumor to the average counts of the normal region, since the most aggressive part of a tumor may be represented by the area of the maximum counts. The ^{99m}Tc-ECD CBF study showed significantly increased blood perfusion on dynamic phase imaged and homogeneously increased uptake in the tumor on static images (Fig. 4A, B). The T/B ratio was approximately 1.9. The ^{201}Tl-Cl brain SPECT study also showed increased perfusion on the dynamic images, inhomogeneous tumor uptake on the early static phase image and mild retention on the delayed static images (Fig. 3A, B) The T/B ratio was approximately 3.5 and 3.4 on the early and delayed images, respectively.

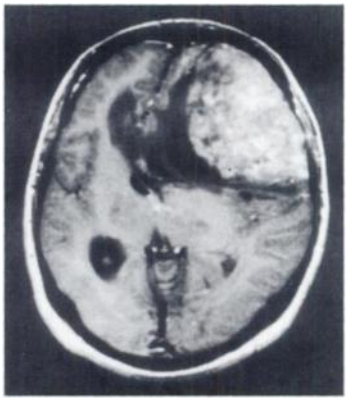

FIGURE 1. Gd-DTPA enhanced brain MR image. There was inhomogeneous enhancement in the tumor with less enhancement at the anterior and medial portion.

One week later, a large 150-g tumor (3.0 × 10 × 12 cm) was surgically resected. Pathological diagnosis was low-grade astrocytoma (Grade II) of protoplasmic type. Three wk later, a repeat brain SPECT study was performed with ^{99m}Tc-ECD and ^{201}Tl-Cl to evaluate blood perfusion and residual tumor. There was a large area of severely decreased uptake in the right frontal lobe on the ^{99m}Tc-ECD CBF study (Fig. 4C, D). The ^{201}Tl-Cl scan showed a

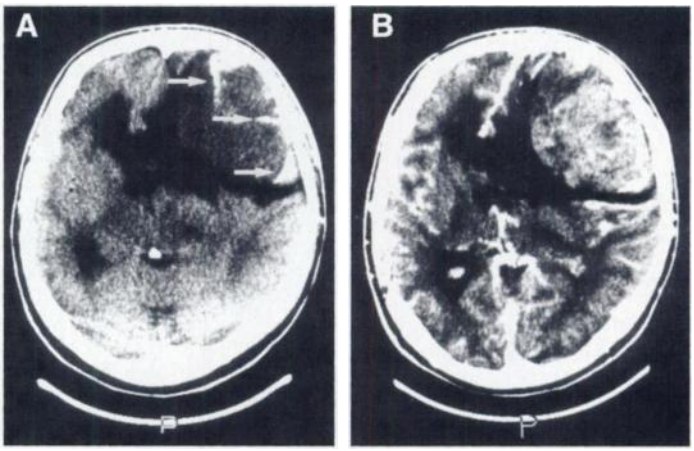

FIGURE 2. (A) Plain and (B) intravenous contrast enhancement brain CT images. Plain CT image demonstrates curvilinear calcification at the periphery of the tumor (white arrows). Contrast-enhanced image shows inhomogeneous enhancement with less enhanced areas in the center, anterior and medial portions.

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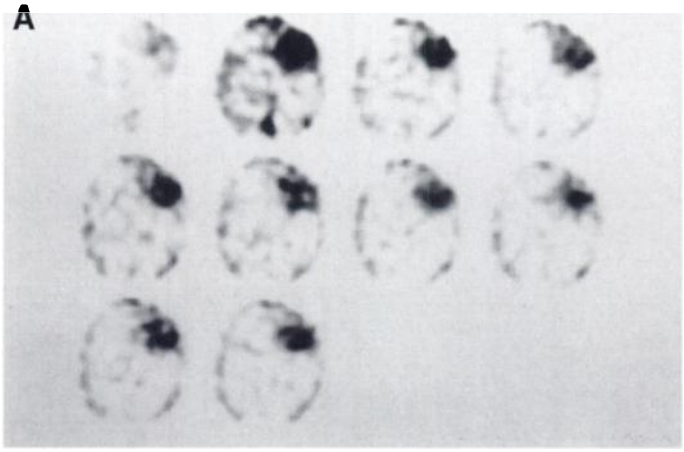
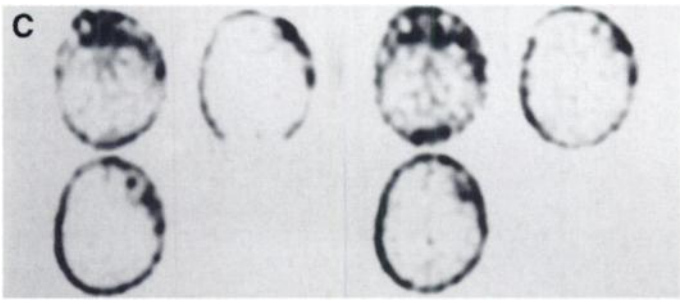




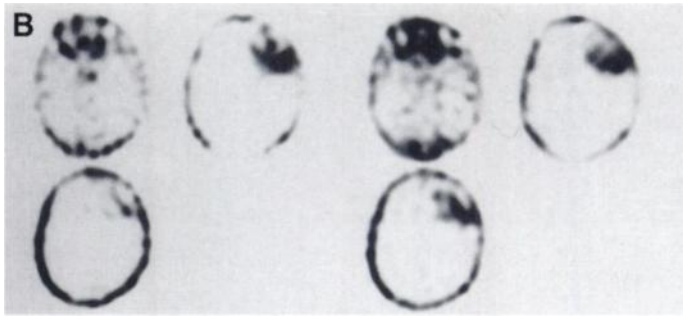


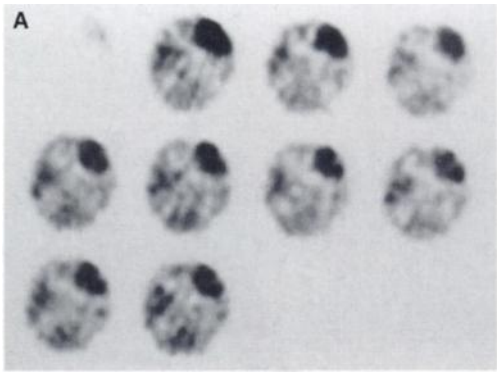
FIGURE 3. Thallium-201-Cl brain SPECT images before (A, B) and after (C) partial tumor resection. Thallium-201-Cl dynamic images (A) demonstrate increased peak accumulation in the tumor on the second frame and then gradually decreased and eccentric localization of tumor uptake. Static images show localized accumulation in the posterior and lateral portions of the tumor on the early (left) and delayed (right) images before surgery (B). There was faintly increased uptake and mild retention on the early (left) and delayed (right) images after surgery (C).

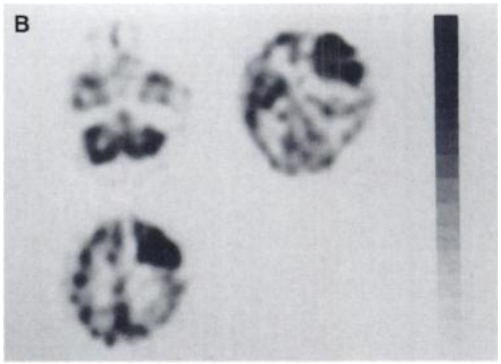
small area of increased uptake on the early static images and mild retention of ^{201}Tl-Cl on the delayed images, which was suggestive of residual tumor (Fig. 3C). The T/B ratio was approximately 2.8 and 2.4 on the early and delayed images, respectively. Irradiation treatment was started.

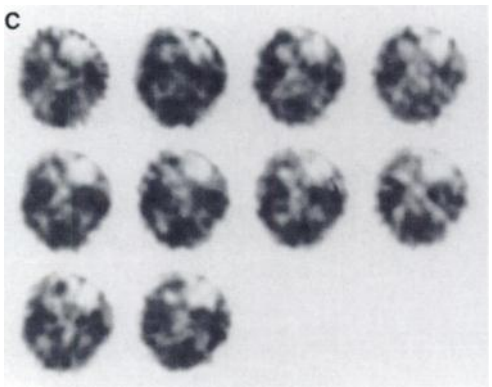
DISCUSSION

Cerebral blood flow imaging agents can easily penetrate the intact BBB and are passively extracted by brain tissue. Once they enter the brain tissue, they are rapidly metabolized and stay in the tissue for a long time (*1–2*). Technetium-99m-HMPAO and ^{99m}Tc-ECD in the circulating blood are rapidly metabolized into a polar substance and cleared from the blood pool by the kidneys. Iodine-123-IMP is more stable in vivo than the former two compounds and shows redistribution on delayed images (*3*). Although ^{99m}Tc-HMPAO and [^{123}I]IMP showed decreased uptake or defects in most of the brain tumors (*4–5*), some of them, hypervascular tumors such as meningiomas and high grade astrocytomas have been reported to show increased uptake (*6–9*). Technetium-99m-HMPAO tends to accumulate in brain tumors more often than ^{123}I-IMP does. Winchell et al. reported that [^{123}I]IMP bound itself to nonspecific, high capacity binding sites for amines (*10*) and the decreased uptake has been reported to represent a lack of binding sites in the lesions. Ell et al. (*11*) speculated that increased extraction efficiencies and/or increased amine receptors could account for increased [^{123}I]IMP uptake (*1*).

In our patient, the tumor showed significantly increased perfu-







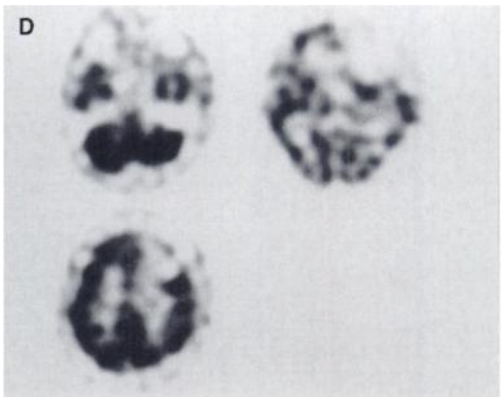


FIGURE 4. Technetium-99m-ECD brain SPECT images before (A, B) and after (C, D) partial tumor resection. Technetium-99m-ECD dynamic images demonstrate increased and relatively homogeneous accumulation throughout the tumor (A). Static images also show relatively homogeneous accumulation in the tumor (B). After surgery, dynamic (C) and static (D) images show a large area of decreased uptake in the right frontal lobe.

sion in the early dynamic phase of both the ^{99m}Tc-ECD and ^{201}Tl-Cl studies. The ^{99m}Tc-ECD study showed relatively homogeneous accumulation throughout the tumor on static images but ^{201}Tl-Cl showed more localized and eccentric accumulation than ^{99m}Tc-ECD on the early and delayed views. Thallium-201-Cl uptake is believed to reflect viable tumor tissue and the degree of ^{201}Tl-Cl retention to represent tumor malignancy. We cannot explain why there was a big difference between ^{99m}Tc-ECD and ^{201}Tl-Cl uptake. We thought that ^{99m}Tc-ECD was a simple lipophilic chelating agent and that increased extraction efficiencies could account for its increased uptake in brain tissue. If ^{99m}Tc-ECD bound itself to nonspecific, high capacity binding sites in brain tumors, we could expect that the ^{99m}Tc-ECD CBF study would show increased accumulation in brain tumors more often than it did. In our experience, almost all of the brain tumors showed decreased uptake or filling defect on ^{99m}Tc-ECD study. Therefore, it is difficult to explain this tumor accumulation by increased blood perfusion, increased extraction efficiency and nonspecific binding sites. Some specific binding sites or mechanism could be considered in such a rare case of increased uptake of ^{99m}Tc-ECD.

CONCLUSION

Although ^{99m}Tc-ECD appears to be a promising agent for the noninvasive evaluation of cerebral blood perfusion, further work is needed to assess pharmacokinetic properties of ^{99m}Tc-ECD accumulation in brain tumors. There is also a potential limitation to evaluate recurrent or residual brain tumor because of background interference from normal brain uptake.

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Left Ventricular Myocardial Uptake of a Labeled Somatostatin Analog in Carcinoid Syndrome

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We report a case of left ventricular (LV) myocardial uptake of a labeled somatostatin analog in a patient with a carcinoid tumor of the small bowel. The patient developed liver metastases and a carcinoid syndrome, including right carcinoid heart disease, without right-to-left shunt on contrast ultrasonography or left ventricular myocardial metastases. The basis for visualization of the LV myocardium is probable somatostatin receptor upregulation.

Key Words: carcinoid; indium-111-pentetreotide; myocardial uptake

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Various neuroendocrine tumors, including carcinoid tumors, express many high-affinity somatostatin receptors, a property exploited for in vivo imaging by somatostatin analog scintigraphy with ^{111}In-pentetreotide. The presence of somatostatin receptors in carcinoid tumors can be used to detect primary tumors and metastases and may be predictive of the efficacy of somatostatin analog therapy. We report myocardial uptake during somatostatin receptor scintigraphy in a patient with a carcinoid tumor and carcinoid heart disease.

CASE REPORT

In May 1988, a 65-yr-old woman was admitted for investigation of gastric polyposis. The initial exploration, including abdominal ultrasound, colonoscopy and a small-intestinal series, was normal. Biopsy of the gastric polyps suggested benign glandular cystic polyposis.

Three years later, she was admitted for acute pain in the right upper abdomen and weight loss. Ultrasound, CT and MRI detected a liver mass 6 cm in diameter in segment IV, with a slight compression of the liver pedicle. Biopsy showed that the lesion was a metastasis of a carcinoid tumor. The primary tumor was not discovered despite complete exploration. The plasma serotonin was elevated (450 mg/liter, normal <300). During exploratory surgery, the liver metastasis was removed and a 1-cm diameter tumor in the terminal ileum was discovered and also removed. Histological examination confirmed the diagnosis of a carcinoid tumor. After surgery, the serotonin level continued to rise (1593 mg/liter 1 yr later).

Two years later, the patient developed symptoms of carcinoid syndrome, including cutaneous flushing, weight loss, leg swelling

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