

# Abnormal Intracerebral Thallium Localization in a Bacterial Brain Abscess

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A 56-yr-old man with a prior history of renal cell carcinoma had moderately intense abnormal localization of  $^{201}\text{Tl}$ -chloride in a solitary brain lesion which was discovered to be a bacterial abscess. The organisms isolated by culture included *Actinomyces odontolyticus*, *Peptostreptococcus* and *Hemophilus aphrophilus*. Because of the clinical presentation, MRI characteristics and thallium scintigraphic findings, the lesion had been felt to represent either a primary or a metastatic neoplasm. This case illustrates the need for caution in the interpretation of thallium brain scintigram.

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Thallium-201 scintigraphy is being increasingly utilized in the management of gliomas, both for grading on initial presentation, and for detection of viable tumor after treatment (1-7). Thallium has also been shown to localize in meningiomas, metastases, hematomas and cerebral infarctions (8-10). Recently, abnormal thallium uptake has also been described in an infectious intracerebral lesion due to candidiasis (11). We now report a case of thallium-201 uptake in a cerebral abscess involving *Actinomyces odontolyticus*, *Hemophilus aphrophilus* and *Peptostreptococcus*.

## CASE REPORT

A 56-yr-old male presented with a change in mental status, problems of memory and gait, severe headache and diplopia. Previous medical history was significant for hypernephroma of the left kidney for which a nephrectomy had been performed 3.5 yr ago.

Neurological examination detected poor memory and insight, a flat affect, right motor drift and ataxia. Other significant findings on physical exam included a molar abscess. The affected tooth was removed and grew *Candida albicans* on culture. The patient had an ESR of 45 mm/hr and a total WBC count of  $4.4 \times 10^3 \mu\text{l}$  with 77% neutrophils, 11% lymphocytes, 9% monocytes and 2% basophils. Chest and abdominal x-rays were unremarkable except

for a calcified granuloma in the left lung. MRI of the brain showed a large,  $6.7 \times 4 \times 5$  cm, irregularly marginated, rim enhancing, multilobulated lesion with a cystic component in the left frontal lobe. An area of high T2 signal intensity was seen at the margin of the mass within the deep white matter, and extended into the genu of the corpus callosum, compatible with edema (Fig. 1). There was a marked mass effect with effacement of the left frontal and parietal sulci, and the left lateral ventricle, with approximately 1 cm of subfalcian herniation. Based on its MRI characteristics, size, and solitary nature, the lesion was thought to represent most probably a primary glioma, or less likely, a metastasis from renal cell carcinoma.

## Radionuclide Imaging

The patient was injected with 3.7 mCi (137 MBq) of  $^{201}\text{Tl}$ -chloride intravenously. Acquisition of SPECT images was initiated 20 min postinjection, using a single-head camera (GE 3000 XC/T). Sixty-four images were acquired in a  $64 \times 64$  matrix over  $360^\circ$ , at 40 sec per view, with an average of 8,000 counts per view. Images were reconstructed with a Butterworth prefilter of 0.25/cm initial frequency and a power factor of 10 using an attenuation correction of 0.12/cm, and backprojection with a ramp filter.

The patient's scan demonstrated a focal dumbbell shaped area of abnormal increased activity in the left frontal lobe (Fig. 2). The shape and extent of this activity corresponded closely with the regions of gadolinium enhancement seen in the MRI examination. A quantitative thallium-tumor index was computed using a ratio of the activity at the lesion site to a mirror image site in normal brain. The thallium tumor index was 2.2.

A functional brain imaging study using  $^{99\text{m}}\text{Tc}$ -hexamethylpropyleneamine oxime (HMPAO) was also performed, following

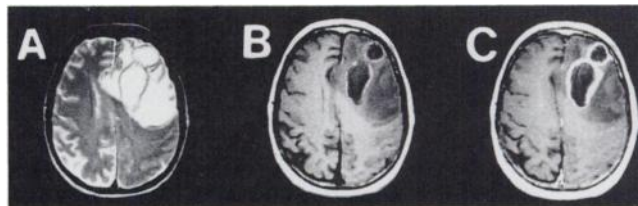
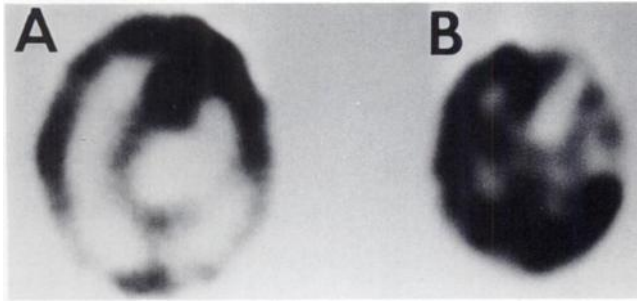


FIGURE 1. (A) Axial T2-weighted image (1.5T, SE 2,200/80) showing the multi-lobulated lesion and surrounding edema in the left frontal cerebral hemisphere. (B) Axial T1-weighted image (1.5T, SE 450/15) showing the left frontal lobe cystic lesion. (C) Axial T1-weighted image after gadopentetate dimeglumine administration (1.5 T, SE 450/15) demonstrates contrast enhancement of the borders of the multi-lobulated cystic mass.

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**FIGURE 2.** (A) SPECT  $^{201}\text{Tl}$ -chloride image, axial view at level of MRI images in Figure 1 showing abnormal increased activity in the area of the lesion in the left frontal lobe. (B) SPECT  $^{99\text{m}}\text{Tc}$ -HMPAO image, axial view at a corresponding level, demonstrating abnormally reduced activity throughout the left frontal lobe and a portion of the left parietal lobe along with a more focal oval zone of absent activity anteriorly, corresponding to the sites of abscess and surrounding edema.

the thallium study. The patient was injected with 25.7 mCi (951 MBq) of  $^{99\text{m}}\text{Tc}$ -HMPAO intravenously. Acquisition of SPECT images was initiated 3 hr postinjection using the same camera. Sixty-four images were acquired in a  $64 \times 64$  matrix over  $360^\circ$  at 20 sec per view, with an average of 51,000 counts per view. The radius of rotation was 14 cm. Images were reconstructed with a Butterworth prefilter of 0.35 critical frequency and power factor of 10, using an attenuation correction of 0.12/cm and backprojection with a ramp filter.

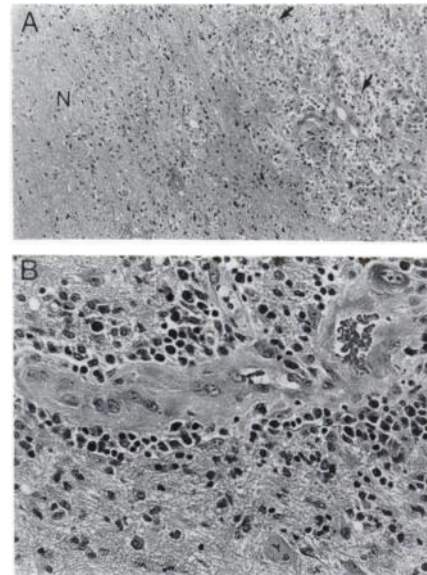
These images demonstrated an extensive area of markedly decreased activity encompassing the left frontal lobe, anterior region of the left parietal lobe and part of the caudate nucleus. Within this area, there was a small oval shaped zone of absent activity (Fig. 2). Also present was mildly decreased activity in the right frontal lobe anteriorly, right parietal lobe posteriorly and the right cerebellar hemisphere. The configuration, location and extent of the left hemisphere abnormalities were similar to the abnormal regions on the MRI exam. The right hemispheric changes had no corresponding anatomical abnormalities by MRI scan. The location and extent of the abnormal thallium uptake closely matched the zone of absent activity seen on the  $^{99\text{m}}\text{Tc}$ -HMPAO brain scan.

Based on the clinical, MRI and scintigraphic findings, a preoperative diagnosis of the brain tumor was made. The lesion was thought to represent either a glioma or metastatic renal cell carcinoma. In order to obtain definitive diagnosis, a left frontal craniotomy was performed. A cystic lesion containing purulent fluid was found. The cavity containing the cystic fluid was extirpated and tissue was submitted for microbiological, histopathological and tissue culture studies.

### Pathology

Histopathologic appearances were compatible with an organized bacterial abscess (Fig. 3). Noteworthy, was the intensity of endothelial proliferation and fibroblastic ingrowth associated with cytologic atypia and astrocytosis (Fig. 3). Gram positive cocci were identified in necrotic areas. Anaerobic microbial culture of the cystic fluid revealed *Actinomyces odontolyticus*, *Hemophilus aphrophilus* and *Peptostreptococcus*.

The patient was treated with parenteral penicillin, ceftriaxone and metronidazole, leading to clinical improvement of the neurological deficits as well as radiological resolution of the lesion.



**FIGURE 3.** (A) Areas of coagulative necrosis (N) containing inflammatory cells and karyorrhectic debris, surrounded by a zone of active endothelial ingrowth (arrows) and chronic inflammatory cells (Hematoxylin and eosin  $\times 50$ ). (B) High magnification of a reactive vessel in the wall of the bacterial abscess with prominent endothelial cells and perivascular polymorphous (mostly round cell) infiltrate. Note reactive astrocytes and a mitotic figure in the lower part of the microphotograph (Hematoxylin and eosin  $\times 600$ ).

### DISCUSSION

Recent investigations have documented a potential role for  $^{201}\text{Tl}$  scintigraphy in both the preoperative and postoperative evaluation of patients with cerebral lesions suspected of being viable tumor (1-7). Reports of thallium uptake in lesions of an infectious etiology are few and relatively recent. They include thallium uptake in cerebral candidiasis (11) and pulmonary actinomycosis (12).

The mechanism of thallium uptake has been studied extensively, but the details have not been elucidated in their entirety. Cellular uptake of thallium is now thought to involve three transport systems. These include the  $\text{Na}^+$ - $\text{K}^+$  ATPase system, the  $\text{Tl}^+$ - $\text{Na}^+$ - $2\text{Cl}^-$  cotransport system as well as the  $\text{Ca}^{2+}$ -dependent ion channel (13-15). Other factors influencing thallium uptake in a lesion include blood flow, viability, cell membrane permeability and tumor type (16).

Microautoradiographic studies performed by Mountz et al. showed specific uptake of thallium by the high-grade astrocytoma cells, as compared to adjacent uninvolved brain tissue or necrotic tissues (17). Distribution of thallium in tumor tissues and inflammatory lesions has been studied in rats by Ando et al. (18). The results of this study indicated that thallium accumulated mainly in tumor tissue, to a lesser extent in connective tissue, and minimal amounts were seen in necrotic tissue. In inflammatory lesions, it was seen that thallium accumulated in subcu-

taneous tissues, specifically in neutrophils and macrophages (18).

Thallium scintigraphy was performed on this patient as part of an ongoing evaluation at our institution of all patients with suspected brain tumors (19). The diagnosis of cerebral abscess in this patient was unexpected since the clinical, radiological and scintigraphic findings favored the presence of a neoplasm. The patient had no known risk factors for a cerebral abscess.

Infection of the central nervous system (CNS) with *Actinomyces* is relatively uncommon and usually presents as a cerebral abscess (20). Other CNS lesions include meningitis, meningoencephalitis, subdural and epidural empyemas. The most common causative organism isolated is *A. israelii*, whereas *A. propionica* and *A. odontolyticus* have been rarely implicated in CNS lesions (21, 22).

The uptake of thallium in this patient's abscess, may have been due to the presence of intense reactive gliosis and endothelial proliferation which was observed around the abscess.

The possibility of <sup>201</sup>Tl localization in non-neoplastic processes such as the abscess discovered in this patient indicates the need for caution when interpreting <sup>201</sup>Tl scintigrams performed during brain tumor evaluations and highlights the value of establishing a concomitant definitive tissue diagnosis. The degree to which the chronicity of the lesion, the severity of the associated pathologic features, i.e., necrosis, inflammation, reactive gliosis, and neovascularization contributes to thallium uptake in a brain abscess requires further investigation.

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