Detection of neoplastic meningitis in a patient with gastric cancer by thallium-201 SPECT

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ABSTRACT

We describe the usefulness of thallium-201 SPECT in a patient with neoplastic meningitis (NM) from gastric carcinoma. Thallium-201 SPECT is of value for the diagnosis of cancer; retention of thallium-201 on delayed images strongly suggests malignancy. NM is a lethal, major neurologic complication of cancer. The standard for the diagnosis of NM is cytologic confirmation of malignant cells in CSF, but cytologic results are often negative (estimated false negative rate, 50%), even when NM is strongly suspected clinically. In patients with equivocal findings, our findings suggest that thallium-201 SPECT is one helpful tool for the detection of NM, particularly when associated with signet-ring cell carcinoma.

CASE REPORT

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An 87-year-old woman with a 7-year history of slightly impaired memory presented with unusual behavior and an altered mental state. Subsequently, partial seizures involving the right hand and secondary generalized seizures developed. The patient was admitted to our hospital. She was comatose, but responded to pain stimulation. Meningismus was absent. Both eyes deviated to the left. Blood cell counts and the results of routine biochemical analysis were normal. Serum carcinoembryonic antigen was increased (15.3 ng/ml). EEG was abnormal, with spike waves in the left frontal and temporal regions. MRI Gadolinium enhancement appeared in meninges of the left frontal and temporal lobes, but not in the brain parenchyma (Fig. 1D). High-intensity regions were not evident on same axial views of T2-weighted MRI and FLAIR images, shown in Fig.1D (Fig.1E and F). Another axial slices of T2-weighted MRI and FLAIR showed mildly increased intensity in the left frontal and temporal lobes, suggesting brain edema. Cranial enhanced CT showed leptomeningeal enhancement in the left frontal and temporal lobes (Fig. 2). A thallium-201 brain SPECT scan was obtained with a three-headed gamma camera system (Siemens MULTISPECT 3). The thallium-201 study was performed 15 min (early scan) and 3 hours (delayed scan) after the intravenous injection of 148 MBq (4 mCi) of thallium-201. A 128 × 128 matrix was used for imaging. Delayed thallium-201 SPECT showed abnormal uptake in the same location as the regions with gadolinium enhancement on MRI (Fig.1B). The early scan showed mild thallium uptake in the same regions (Fig.1A). An abdominal CT scan showed irregular thickness of the gastric wall from the cardia to the body of the stomach near the body of the pancreas (Fig.3), with enlarged surrounding lymph nodes. FDG PET showed deoxyglucose uptake in a wide area of the

stomach and the head of the pancreas (Fig.4A), with no apparent uptake in the brain (Fig.1C) and spinal canal (Fig.4B). Anticonvulsant and antiedema medications were started, but more aggressive treatment such as chemotherapy and radiation was withheld at the family's request. Three weeks after admission, the patient died. Informed consent had been obtained for immediate lumbar puncture after death. CSF analysis showed increased concentrations of protein (413 mg/dl) and carcinoembryonic antigen (93.8 ng/ml). Cytologic examination of the CSF revealed signet-ring cells (Fig.5).

DISCUSSION

Neoplastic meningitis is an often lethal, major neurologic complication of cancer. Neoplastic meningitis most commonly occurs in patients with leukemia, breast cancer, lymphoma, and lung cancer. Neoplastic meningitis associated with gastric carcinoma is rare, accounting for only 0.19% of all cases (1), and the most histologic type is signet-ring cell carcinoma (2). Although there was no pathological diagnosis of a primary tumor in our patient, the presence of signet-ring cells in the CSF and the findings on FDG PET and abdominal CT strongly suggested neoplastic meningitis from gastric adenocarcinoma.

We detected abnormal uptake on thallium-201 SPECT, particularly the delayed images in the same sites as the gadolinium enhancement of the temporo-frontal meninges on T1-weighted MRI. Thallium SPECT is of value for the diagnosis of cancer; retention of thallium-201 on delayed images strongly suggests malignancy (3). Previously, thallium-201 uptake on SPECT was reported in only one patient who had neoplastic meningitis with breast cancer (4). However, the report provided no details on the results of delayed thallium-201 scanning, MRI, or CSF cytologic examination. Thallium SPECT in a patient with neoplastic meningitis (4) has shown marginated and strongly increased accumulation, similar to that found in patients with brain tumors (5). Thallium delayed images in our patient were characterized by unmarginated zones of increased accumulation in which strong and weak accumulations coexisted. Gadolinium-enhanced MRI in neoplastic meningitis shows diffuse and linear or nodular focal enhancement of the surface of the brain or spinal cord as seen in our patient (6,7), which is known to be specific for neoplastic meningitis (8). Our observations suggest that neoplastic meningitis lesions can be detected on thallium SPECT as well as enhanced MRI, but assessment of lesion extent or structural changes is very difficult on the former. Confirmation of the clinical usefulness of thallium SPECT for neoplastic meningitis must await further studies.

The mechanisms underlying these findings are unknown, but several factors are considered important. Thallium is a potassium analog that is transported into tumor cells in place of potassium Na+,K+-adenosine triphosphate (ATPase), which is dependent on blood flow (3). On delayed SPECT, thallium-201 accumulates more in Na+,K+-ATPase-positive adenocarcinoma than in Na+,K+-ATPase-negative adenocarcinoma (9). Moreover, early uptake of thallium appears to be related to tumor vascularity and disruption of the blood-brain barrier (10). In our patient, gadolinium enhancement, considered a reliable marker of disruption of the blood-brain barrier (11), was present in the lesions showing increased thallium-201 uptake. These factors may have thus led to the increased tracer accumulation on thallium-201 SPECT.

The gold standard for the diagnosis of neoplastic meningitis is cytologic confirmation of malignant cells in CSF, but cytologic results are often negative (estimated false negative rate, 50%), even when NM is strongly suspected clinically (12). In patients with equivocal findings, our findings suggest that thallium-201 SPECT is one helpful tool for the detection of neoplastic meningitis, particularly when associated with signet-ring cell carcinoma.

TEACHING POINT

The gold standard for the diagnosis of neoplastic meningitis is cytologic confirmation of malignant cells in CSF, but cytologic results are often negative. In patients with equivocal findings, our findings suggest that thallium-201 SPECT is one helpful tool for the detection of neoplastic meningitis, particularly when associated with signet-ring cell carcinoma, which needs to be confirmed in further studies.

ABBREVIATIONS

SPECT = Single-photon-emission computed tomography
MRI = Magnetic resonance imaging
FLAIR = Fluid-attenuated inversion recovery imaging
PET = Positron emission tomography
FDG = Fluorine-18 fluorodeoxyglucose
CSF = Cerebral spinal fliud
CT = Computerized tomography
EEG = Electroencephalography

REFERENCES

1. Giglio P, Weinberg JS, Forman AD, Wolff R, Groves MD. Neoplastic meningitis in patients with adenocarcinoma of the gastrointestinal tract. Cancer. 2005;103:2355-62.

2. Iwa N, Masuda K, Yutani C, et al. Cerebrospinal fluid cytology with carcinomatous meningitis from gastric cancer: report of three cases. J Jpn Soc Clin Cytol.1985;24:178-182. (Abstract in English)

3. Higashi K, Ueda Y, Sakuma T, et al.Comparison of [(18)F]FDG PET and (201)Tl SPECT in evaluation of pulmonary nodules. J Nucl Med.2001;42:1489-96.

4. Watanabe N, Shimizu M, Noguchi K, Kawabe H, Tonami N, Seto H. Detecting meningeal carcinomatosis from breast cancer with thallium-201 SPECT. Ann Nucl Med.2000;14:379-81.

5. Buchpiguel CA, Alavi JB, Alavi A, Kenyon LC. PET versus SPECT in distinguishing radiation necrosis from tumor recurrence in the brain. J Nucl Med. 1995;36:159-64.

6. Giglio P, Weinberg JS, Forman AD, Wolff R, Groves MD. Neoplastic meningitis in patients with adenocarcinoma of the gastrointestinal tract. Cancer. 2005;103:2355-62.

7. Freilich RJ, Krol G, DeAngelis LM.Neuroimaging and cerebrospinal fluid cytology in the diagnosis of leptomeningeal metastasis. Ann Neurol. 1995;38:51-7.

8. Chamberlain MC, Sandy AD, Press GA.Leptomeningeal metastasis: a comparison of gadolinium-enhanced MR and contrast-enhanced CT of the brain.Neurology. 1990;40:435-8.

9. Takekawa H, Itoh K, Abe S, et al. Thallium-201 uptake, histopathological differentiation and Na-K ATPase in lung adenocarcinoma. J Nucl Med.1996;37:955-8.

10. Buchpiguel CA, Alavi JB, Alavi A, Kenyon LC. PET versus SPECT in distinguishing radiation necrosis from tumor recurrence in the brain.J Nucl Med.1995;36:159-64.

11. Floris S, Blezer EL, Schreibelt G, et al. Blood-brain barrier permeability and monocyte infiltration in experimental allergic encephalomyelitis: a quantitative MRI study. Brain.2004;127:616-27.

12. Wasserstrom WR, Glass JP, Posner JB. Diagnosis and treatment of leptomeningeal metastases from solid tumors: experience with 90 patients.Cancer.1982;49:759-72.

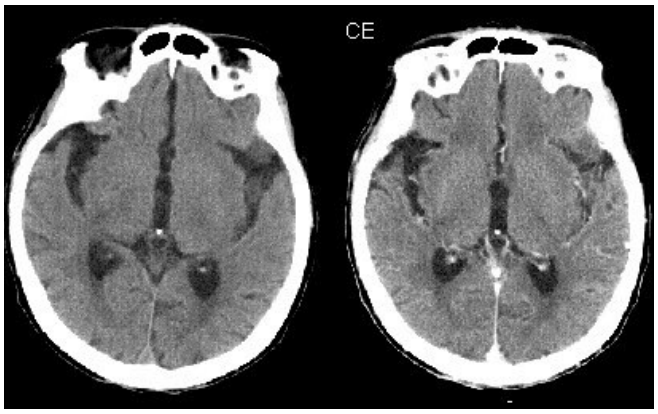

Figure 2: 87 year old woman with neoplastic meningitis from gastric cancer. Cranial contrast enhanced CT showed no apparent parenchymal enhancement. Leptomeningeal enhancement was evident in the left frontal and temporal lobes. CE: contrast enhanced.

FIGURES

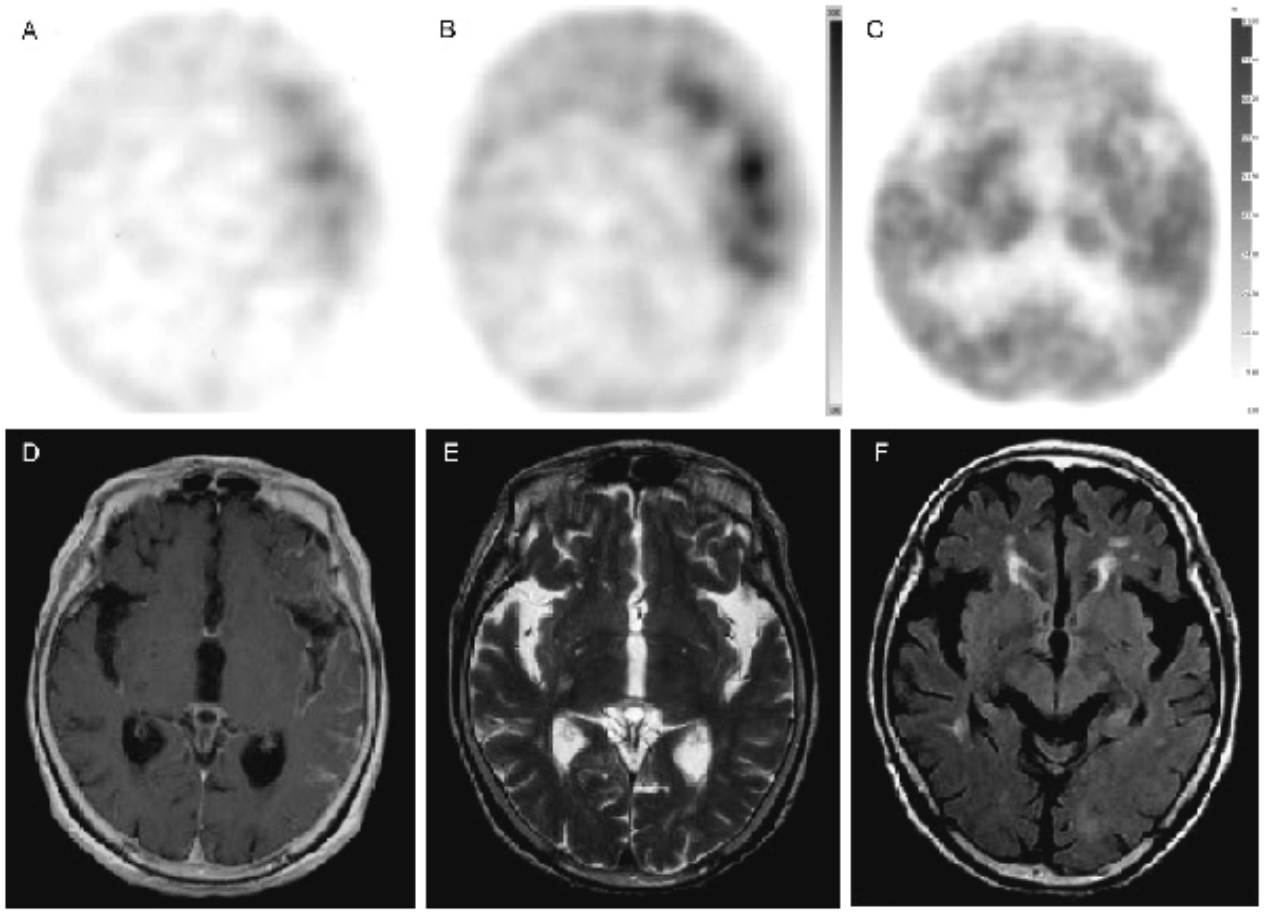

Figure 1: 87 year old woman with neoplastic meningitis from gastric cancer. A gadolinium diethylenetriamine pentaacetic acid (Gd-DTPA) T1-weighted MRI image showing frontal and temporal meningeal enhancement. No enhancement was seen in the brain parenchyma (Panel D). A thallium-201 SPECT study of the brain at the same level showed abnormally strong uptake on delayed imaging (Panel B) and weaker uptake on early imaging (Panel A), consistent with the gadolinium enhancement of the meninges on MRI. FDG PET of the brain showed slight deoxyglucose uptake in the left temporal lobes as compared with the right hemisphere (Panel C). High-intensity regions were not evident on T2-weighted MRI or FLAIR images (Panels E&F).

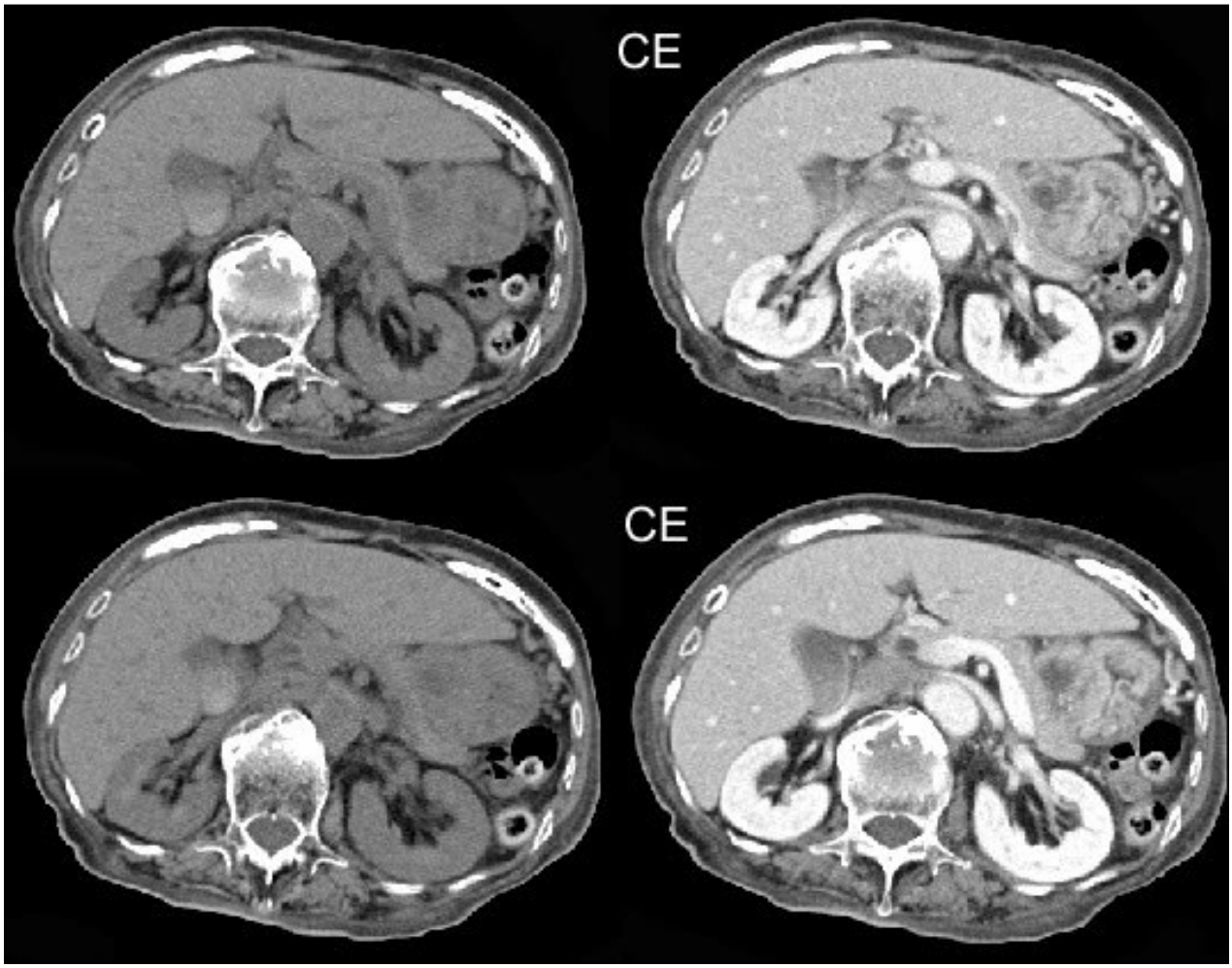

Figure 3: 87 year old woman with neoplastic meningitis from gastric cancer. An abdominal CT scan showed irregular thickness of the gastric wall of the stomach near the body of the pancreas. The gastric wall was contrast enhanced (right panel). CE; contrast enhanced.

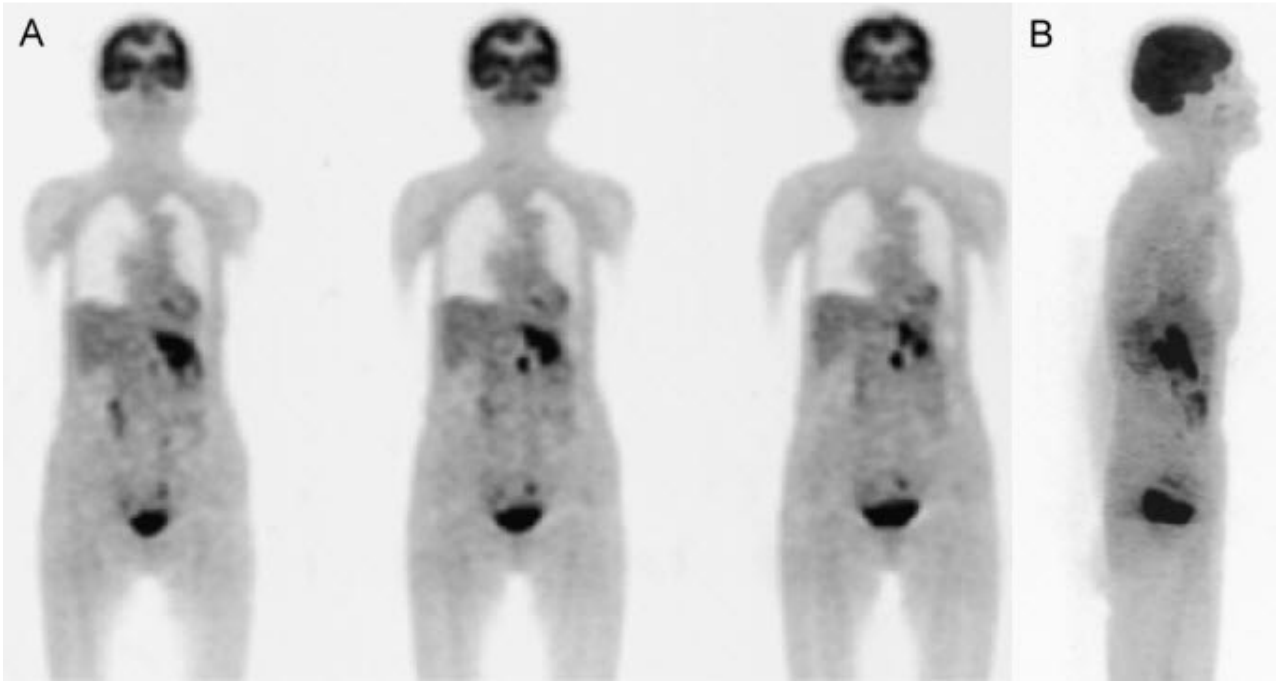

Figure 4: 87 year old woman with neoplastic meningitis from gastric cancer. FDG PET showed deoxyglucose uptake in the stomach and the head of the pancreas (A). No deoxyglucose uptake was apparent in the spinal canal on FDG PET (B).

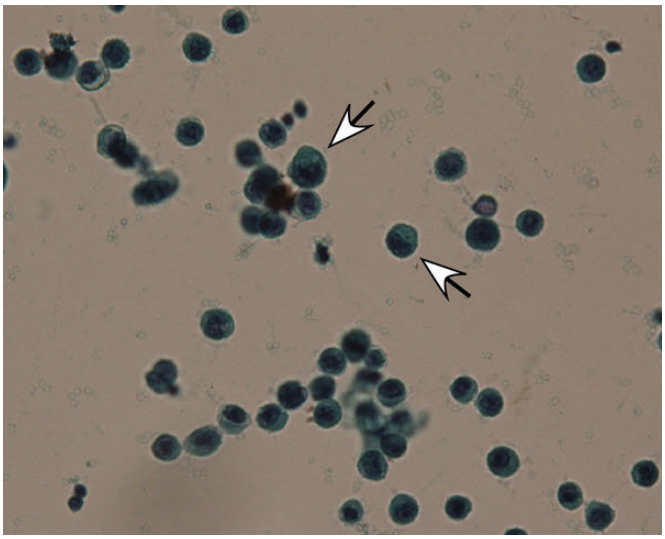

Figure 5: 87 year old woman with neoplastic meningitis from gastric cancer. Cytologic examination of the CSF revealed signet-ring cells. (Papanicolaus stain, ×200)

KEYWORDS

Neoplastic meningitis, gastric cancer , thallium, SPECT