SPECT Imaging in Evaluating Extent of Malignant External Otitis: Case Report

Robert J. English, Sabah S. Tu'Meh, David Piwnica-Worms, and B. Leonard Holman

Brigham and Women's Hospital, Boston, Massachusetts

Otitis externa, a benign inflammatory process of the external auditory canal, is generally responsive to local therapy. Some patients however, develop a less controllable disease leading to chondritis and osteomyelitis of the base of the skull (*1*). The direct invasive characteristic of the disease has led to the descriptive term "malignant" external otitis (MEO), more appropriately called necrotizing or invasive external otitis (*2*). Malignant external otitis is caused by an aggressive *Pseudomonas* or proteus infection that almost exclusively occurs in elderly diabetic patients (*3*).

The primary imaging modalities previously used in the diagnosis and evaluation of MEO were standard planar scintigraphic techniques with technetium-99m (^{99m}Tc) bone agents and gallium-67 (^{67}Ga), and pluridirectional tomography. Scintigraphic modalities generally exceeded polytomography in the initial diagnosis of MEO (*2*). The advent of high resolution computed tomography (CT) effectively allowed demonstration of the soft tissue extension and bone destruction associated with MEO, but still suffered from the low sensitivity constraints of all radiographic techniques in determining early inflammatory bone involvement. Recent work by Strashun et al. (*2*) suggests that scintigraphic detection of MEO with ^{99m}Tc-MDP and ^{67}Ga, combined with the cross-sectional resolution of single photon emission computed tomography (SPECT) may be of value in planning treatment of this inflammatory condition.

CASE REPORT

A 58-yr-old insulin-dependent diabetic man, with a long history of left otitis externa and chronic ear drainage was referred to the nuclear medicine division for bone/gallium scintigraphic evaluation of the extent of active disease. The patient had developed left-sided otitis externa 1 yr prior to admission. Throughout this 1-yr period, he underwent several trials of Carbenicillan and Gentamycin, and two sequential local debridement procedures. Chronic ear drainage (cultured positive for *Pseudomonas aeruginosa*) redeveloped within 2 wk following each procedure. The patient presented as a chronically ill appearing man with left-sided headache, confusion, and left sixth cranial nerve palsy.

Radiographic evaluation by multidirectional tomography of extent of disease showed partial left mastoidectomy and left-sided cortical bone destruction (Fig. 1). Transaxial CT through the base of the skull also revealed the surgical defect, as well as nasopharyngeal soft tissue fullness, and cortical bone destruction on the left side of the foramen magnum and clivus (Fig. 2).

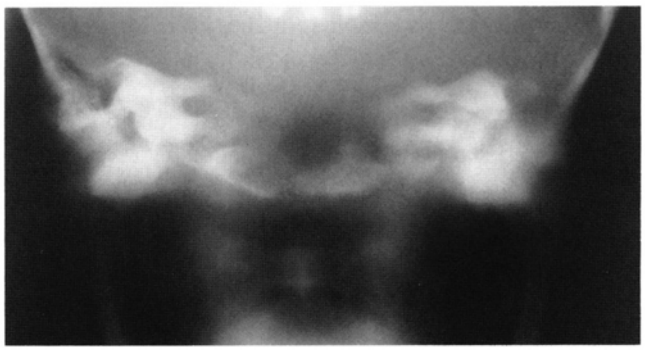

FIG. 1. Multidirectional tomography demonstrating partial mastoidectomy and cortical bone destruction (left is on reader's right).

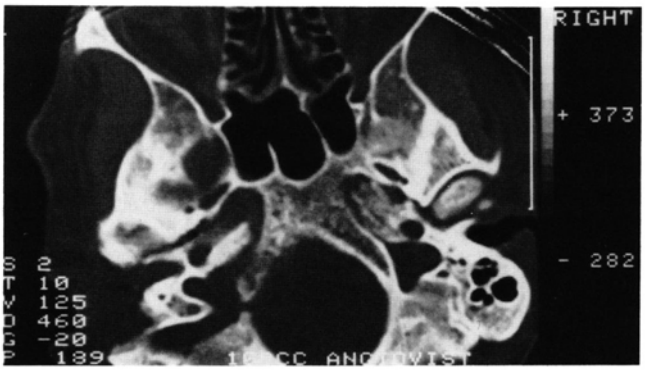

FIG. 2. Transaxial CT slicing through the base of the skull, revealing cortical bone destruction on left side of foramen magnum and clivus (left is on reader's left).

The possibility of further surgical therapy was dependent on the midline extent of disease and warranted the use of SPECT for internal midline evaluation.

SPECT and planar bone studies were performed with a rotating scintillation camera*. After the administration of 17 mCi of ^{99m}Tc-MDP, and a 3-hr waiting period, planar bone images were obtained. The patient was then positioned in a head holder such that the cantho-meatal line was perpendicular to the collimator surface. SPECT acquisition parameters consisted of using a 41-mm thick, low energy general purpose collimator, a 20% window centered on the 140 keV photopeak, 64 projections encompassing a 360° rotation, a 64 × 64 acquisition matrix, and 20 sec per projection.

The projection series was corrected with a 30 million count

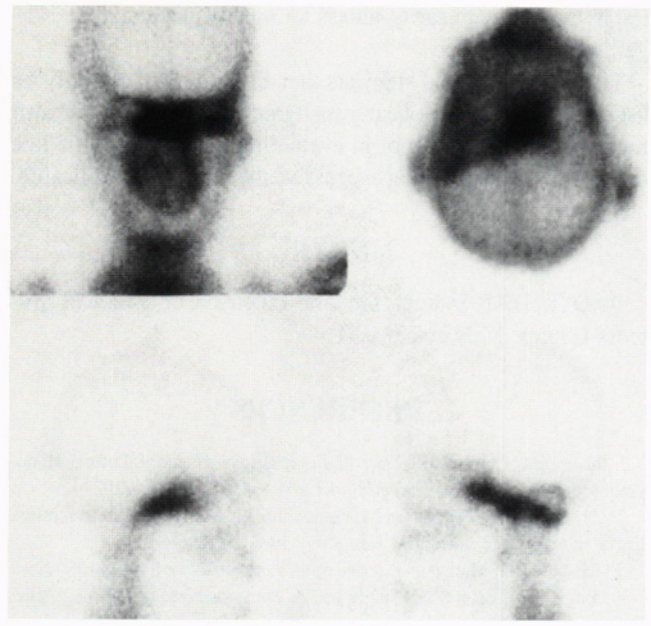

FIG. 3. Planar bone scintigrams demonstrating increased uptake of ^{99m}Tc-MDP in skull base (anterior, vertex, right lateral, left lateral).

extrinsic collected flood, for uniformity variations. The flood corrected images were filtered using a Butterworth filter with a 0.25 cutoff frequency at a 0.20 power factor. The data set was then reconstructed into a transaxial plane with a filtered back projection algorithm employing a straight ramp filter (*4*). The transaxial images of one pixel slice thickness (0.63 cm) were then reoriented into sagittal and coronal planes using a three point oblique reconstruction technique that allows the user to compensate for minimal patient rotation (*4*).

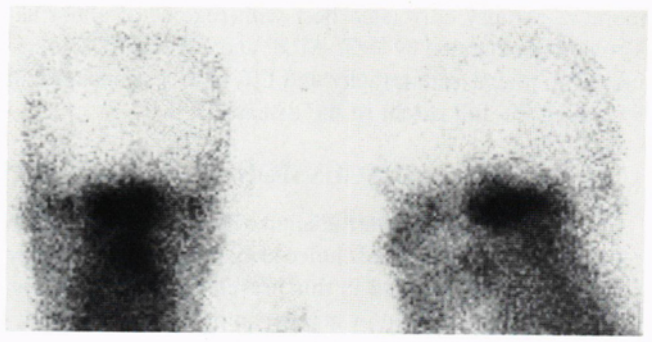

FIG. 4. Planar skull scintigrams revealing increased uptake of ^{67}Ga in the regions of skull base (anterior, left lateral).

Planar and SPECT gallium images were performed 48 hr after a 5 mCi intravenous administration of ^{67}Ga-citrate. A medium energy collimator, and triple 20% windows centered around the 90, 184, and 296 keV photopeaks were used. Tomographic projections were collected on a 64 × 64 matrix, consisting of 64 projections in a 360° arc, for 30 sec per projection. The raw projection data set was corrected for uniformity variations, and reconstructed into transaxial, sagittal, and coronal planes in the manner described for the bone reconstructions.

RESULTS

Computed tomography (Fig. 2) and ^{99m}Tc-MDP and ^{67}Ga planar scintigraphic (Figs. 3, 4) evaluation of the base of the skull were equivocal for midline spread of the infection. Transaxial and coronal SPECT images demonstrated extension of the active osteomyelitis across the midline of the skull base (Figs. 5, 6). The microscopic extent of osteomyelitis eventually

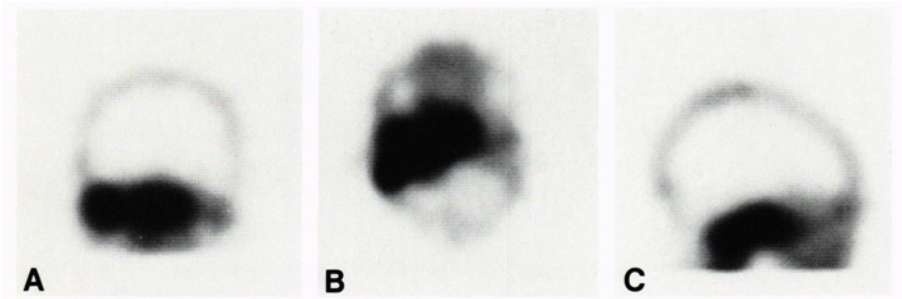

FIG. 5. SPECT bone study demonstrating increased uptake of ^{99m}Tc-MDP extending across the midline of the skull. (A) coronal; (B) transaxial; (C) sagittal.

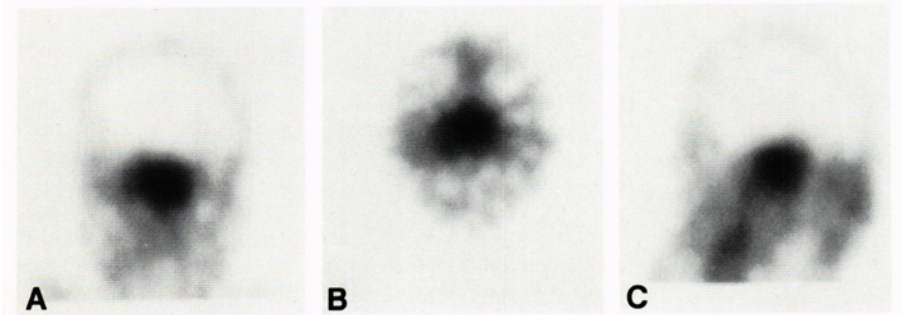

FIG. 6. SPECT skull study presenting increased ^{67}Ga activity across the midline in (A) coronal; (B) transaxial; and (C) sagittal planes.

found at autopsy correlated best with regions of abnormal uptake demonstrated by ^{99m}Tc-MDP and ^{67}Ga SPECT imaging. Both planar scintigraphy and CT were less accurate in localizing the full extent of the disease.

DISCUSSION

Planar scintigraphic determination of bone disease has been reported as the technique of choice prior to aggressive therapy (*5*), but, as demonstrated in this presentation, it suffers on spatial resolution caused by activity in overlying and underlying structures. Computed tomography is often employed in the evaluation of the extent of MEO, but it suffers the same limitations in detecting early osteomyelitis as routine radiographic techniques (*5*). The application of SPECT to this dilemma provides for the increased sensitivity of scintigraphic techniques and the cross-sectional anatomic definition of CT.

The previous application of SPECT in the diagnosis of temporal-mandibular joint disorders has demonstrated the viability of this modality with ^{99m}Tc bone agent distribution in the skull (*6*). SPECT raw projection data from the gallium distribution in the cranium has received less attention because of gallium's unfavorable physical characteristics. Many of the evaluations of gallium's imaging performance were conducted in the early seventies with rectilinear scanners (*7*); however, current Anger camera technology, which includes multiple window capabilities, thicker medium energy collimators, and improved energy linearity, allows for quality planar and SPECT gallium acquisition.

The case presented suggests that SPECT may not only be useful in the detection of early malignant otitis externa, but also may be an important tool in evaluating the extent of the late disease, thereby directing aggressive therapy when applicable.

NOTE

*400AT/STAR System, General Electric Co., Medical Systems Group, Milwaukee, WI.

REFERENCES

1. Kohut RI, Lindsay JR. Necrotizing (malignant) external otitis: Histopathologic process. *Ann Otol Rhinol Laryngol* 1979;88:714–720.

2. Strashun AM, Nejatheim M, Goldsmith ST. Malignant external otitis: Early scintigraphic detection. *Radiology* 1984;150:541–545.

3. Chandler JR. Malignant external otitis. *Laryngoscope* 1968;78:1257–1294.

4. English RJ, Brown SE. Single photon emission computed tomography: A primer. New York: The Society of Nuclear Medicine, 1986.

5. Mendelson DS, Som PM, Mendelson MH, et al. Malignant external otitis: The role of computed tomography and radionuclides in evaluation. *Radiology* 1983;149:745–749.

6. Collier DB, Carrera GF, Messer EJ, et al. Internal derangement of the temporal mandibular joint: Detection by single photon emission computed tomography. *Radiology* 1983;149:557–561.

7. Silberstein ED. Cancer diagnosis: The role of tumor imaging radiopharmaceuticals. *Am J Med* 1976;60:226–237.