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Radiology in Focus

Radiological and radionuclide investigation of malignant otitis externa

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Abstract

This study looks at case series of malignant otitis externa, outlines detailed structural (radiological) and functional (radionuclide) investigations, and discusses their utility in the initial diagnosis, patient management and follow up of this condition.

Patients were investigated by computerized tomography (CT), magnetic resonance imaging (MRI), two-phase planar and single-photon emission tomography (SPECT), technetium-99m methylenediphosphonate bone scans, gallium-67 planar and SPECT scans, and indium-111 or technetium-99m labelled WBC planar and SPECT scintigraphy.

We discuss example case reports with the various radiological and scintigraphic findings and outline a protocol for rational investigation.

It is concluded that CT and/or MRI should be supported by routine SPECT bone imaging for initial diagnosis of malignant otitis externa. Routine SPECT bone imaging further supplemented by gallium scintigraphy should be the investigation of choice in the follow up of these cases for assessing response to treatment and disease recurrence.

Keywords: Otitis Externa; Magnetic Resonance Imaging; Tomography, X-Ray Computed; Radionuclide Imaging

Introduction

Malignant otitis externa is a severe, uncommon infective disease of the external auditory canal and skull base known to occur primarily in elderly diabetics and immunocompromised patients.[1,2] It was first described in 1959.[3] It is usually caused by *Pseudomonas aeruginosa*; however, other organisms such as *Aspergillus flavus* have been occasionally isolated.[4,5] Due to its rarity, the diagnosis is often not made promptly. It is a progressive infection that usually begins in the external ear canal or middle ear; however, extension into the deep structures or chronic osteomyelitis may occur without signs of infection on local clinical examination. It can then progress to osteomyelitis of the skull base with multiple cranial palsies. Temporomandibular joint osteomyelitis, sigmoid sinus thrombosis, meningitis and optic neuritis/optic nerve involvement have also been reported.[2,4,6]

Otalgia, out of proportion to the otitis externa, is common. A high index of suspicion is needed. Examination of the ear often reveals granulation tissue in the floor of the external auditory canal near the bone–cartilage junction.[5]

In routine laboratory testing, the white cell count may not be elevated but the erythrocyte sedimentation rate is usually elevated and is the most common laboratory finding.[1]

Despite antibiotic treatment, extension into deeper tissues may still occur. A biopsy of the granulation tissue in the external auditory canal is necessary to exclude carcinoma since the findings may be similar clinically and radiologically.

Ultimately, radiological and radionuclide investigations are needed to diagnose and confirm bony involvement (osteomyelitis) and for monitoring disease regression or progression.

We present examples of malignant otitis externa cases, outlining the radiological and radionuclide

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investigations and showing their utility in the initial diagnosis, patient management and follow up. A rational protocol for investigating malignant otitis externa is suggested.

Case reports

Case 1

A 69-year-old male insulin-dependent diabetic was referred to us with a three-month history of persistent right otalgia despite medical treatment. Otoscopy revealed a large, polypoidal mass occluding the right external auditory canal (EAC). Aural toiletting was performed with medical treatment.

A week later, the patient developed right facial nerve and palatal palsy. A diagnosis of malignant otitis externa was made. He was admitted for treatment. Biopsy of the ear canal revealed chronic granulation tissue on histological examination.

High-resolution computerized tomography (CT) scan of the temporal bone revealed soft tissue density almost occluding the right EAC. The right middle ear cleft, attic, mastoid aditus and antrum were all opacified. There was erosion of the medial wall of the EAC and the posterosuperior wall of the mandibular fossa of the temporomandibular joint. There appeared to be early erosion of the cortex of the right side of the clivus (Figure 1). A magnetic resonance imaging (MRI) scan of the brain and temporal bone suggested a much more extensive abnormality than initially identified on the CT but did not otherwise add anything significant to the findings.

During his admission, the patient's inflammatory markers improved. On completion of six weeks of intravenous antibiotics, indium-111 labelled white blood cell (WBC) planar and single photon emission computed tomography (SPECT) imaging was performed. This showed normal and symmetrical uptake in the skull and mastoid regions bilaterally, with no evidence of active, ongoing infection.

The patient was readmitted three months later with right otalgia and swallowing difficulty. Examination revealed an oedematous right ear canal with right palatal and facial palsy. Repeat CT scan showed bone reformation in the right petrous temporal bone. The previous destructive bone changes were no longer evident.

A planar and SPECT technetium-99m methylenediphosphonate (MDP) bone scan done on completion of six weeks of antibiotic therapy did not show any evidence of active bone infection.

At the time of writing, the patient was asymptomatic apart from residual mild facial palsy.

Case 2

A 72-year-old male non-insulin-dependent diabetic presented with a two-week history of persistent left otalgia despite medical treatment. Otoscopy revealed a large, friable, bleeding polyp in the left EAC.

A high-resolution CT scan of the petrous temporal bone showed opacification of much of the mastoid cells, but there was no obvious bony erosion. The ossicular chains seemed intact. In view of the CT scan report and the patient's persistent otalgia, he underwent a left, modified radical mastoidectomy. No cholesteotoma was found; however, there was granulation tissue and abscess on the floor of the ear canal and in the anterior hypotympanum. Histology revealed chronic inflammation with epithelial inclusion cysts. The patient subsequently developed left vagal and hypoglossal palsies.

A repeat CT scan did not reveal any abnormality at the petrous apex or skull base to suggest

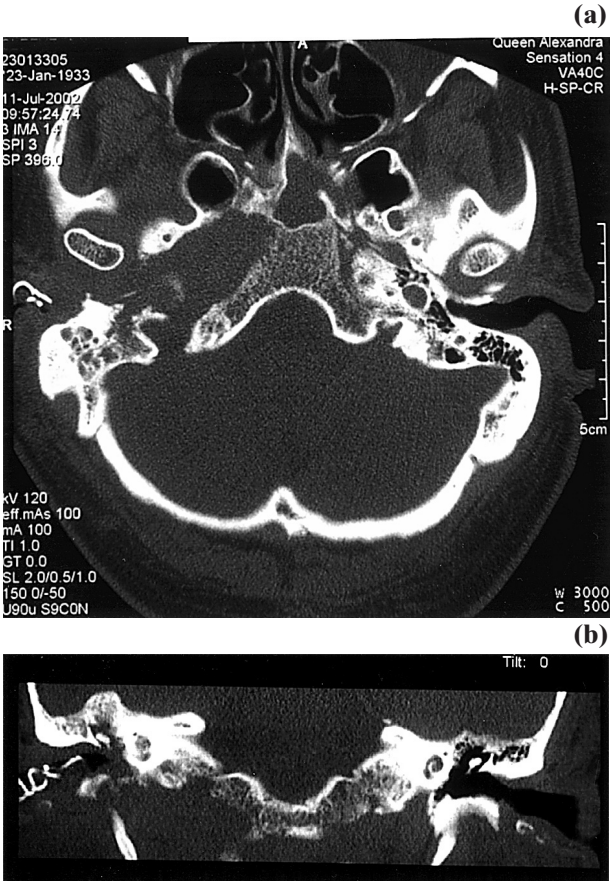

FIG. 1

(a) Axial CT scan of the temporal bone. (b) Coronal CT scan of the temporal bone.

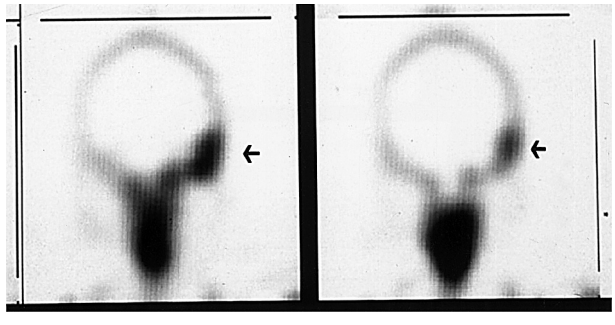

FIG. 2

SPECT technetium bone scan showing increased activity in the left mastoid (arrows).

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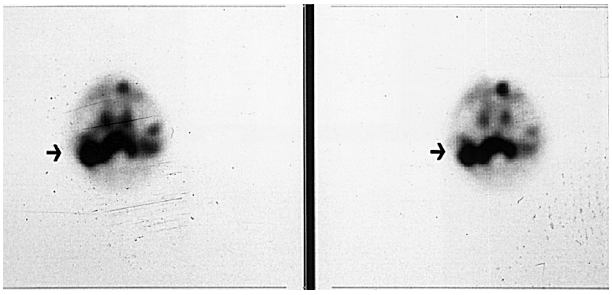

FIG. 3

SPECT technetium bone scan showing increased activity in the right petrous temporal bone (arrows).

osteomyelitis. There were inflammatory changes around the left mastoid. An MRI scan showed some evidence of inflammatory changes across the base of the skull. A SPECT technetium bone scan suggested active subacute bone pathology of the temporal bone, with increased activity in the left mastoid (Figure 2). A subsequent SPECT gallium scan showed only mild increased activity in the left mastoid. There was no evidence of significant active, ongoing osteomyelitis in the left mastoid. Within this period, there was no evidence of active infection in the EAC and middle ear.

Two months after resolution of the left-sided symptoms, the patient presented with right otalgia and facial, vagal and hypoglossal palsies. A repeat SPECT technetium bone scan showed clear-cut, intense increased activity in the right petrous temporal bone, consistent with active, ongoing infection, with normal uptake on the left (Figure 3).

An MRI scan revealed extensive inflammatory changes throughout the right petrous temporal bone, clivus and left petrous apex. There was also dural enhancement in the right middle cranial fossa (Figure 4). The patient was treated with antibiotics and hyperbaric oxygen therapy.

A repeat SPECT bone scan after treatment showed normal and symmetrical uptake in the skull base and petrous bone but there was increased activity seen in the right occipital bone. There was normal activity in both mastoids, confirming resolution of previous, scintigraphically documented infection.

Case 3

An 85-year-old female non-insulin-dependent diabetic presented with a three-week history of left otalgia and otorrhoea which were not responding to medical treatment. She was admitted to enable optimal treatment with intravenous antibiotics and aural toiletting. Otoscopy revealed polypoidal granulation tissue in the floor of the left EAC.

A high-resolution CT scan of the left petrous bone and skull base revealed a left middle ear effusion but no bony destruction to suggest an underlying mass. Histological examination of biopsy from the left EAC showed fragments of squamous epithelium with severe acute inflammation and granulation tissue.

After completing at least six weeks of intravenous

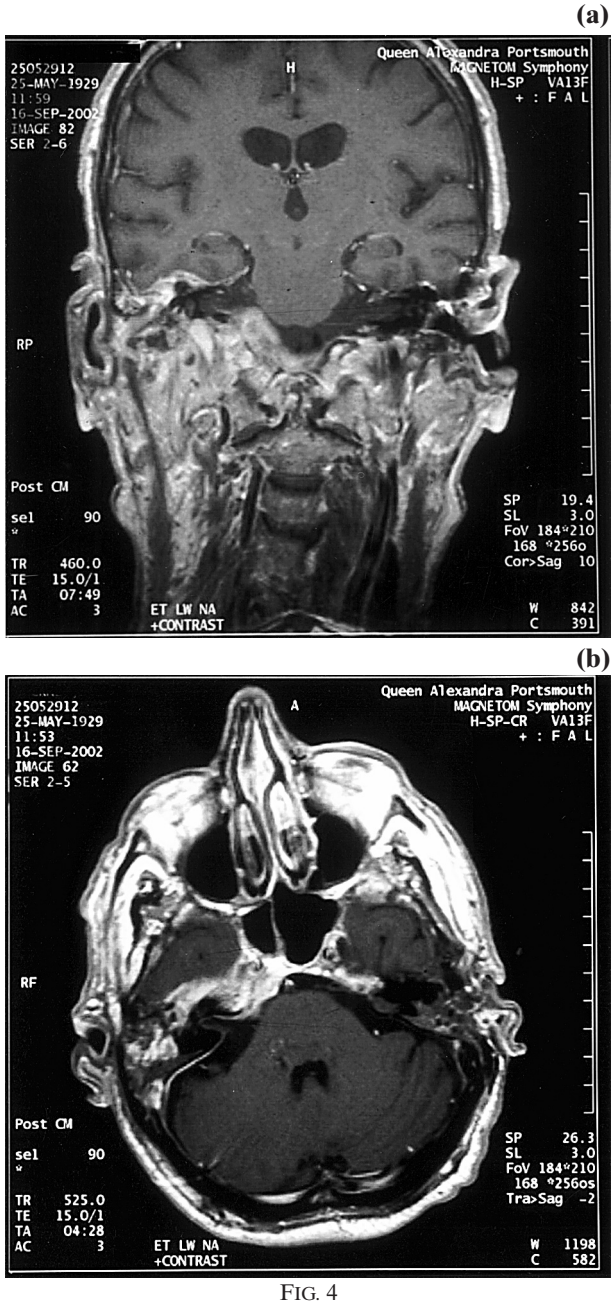

FIG. 4

(a) Coronal MRI scan of the temporal bone. (b) Axial MRI scan of the temporal bone.

antibiotics, a radiolabelled WBC scan was performed. This was normal.

Three months later, the symptoms recurred. Otoscopy revealed a very oedematous left EAC. A repeat CT scan revealed abnormal soft tissue attenuation in the middle ear cleft, although the ossicles, scutum and tegmen tympani appeared intact. No definite bony destruction was seen.

A SPECT bone scan revealed clear-cut increased focal activity in the left mastoid, consistent with left mastoid infection (Figure 5). A WBC-labelled SPECT scan showed normal distribution of activity, with no evidence of focal accumulation of tagged white cells in the mastoid region.

The patient completed a course of antibiotic therapy and at the time of writing remained well.

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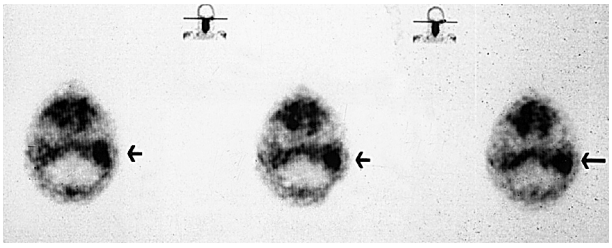

FIG. 5
SPECT technetium bone scan showing increased activity in the left mastoid (arrows).

Discussion

Staging of malignant otitis externa is important for therapeutic reasons. The disease has been described[7] as: stage one, confined to the EAC and/or facial nerve paralysis; stage two, osteitis of the skull base and/or multiple cranial nerve involvement; and stage three, meninges or brain involvement. Stage one disease responds to six weeks of antibiotic therapy while stage three disease requires more prolonged treatment with hyperbaric oxygen therapy.

Successful management of malignant otitis externa requires early detection and treatment. Radiological and radionuclide investigations are needed to confirm the diagnosis and to follow the resolution and/or progression of the disease. These investigations are also useful in the context of staging the disease.

Radiological investigation of malignant otitis externa involves CT and MRI scans. High-resolution CT defines the location and the extent of the disease process. Structural imaging seeks to define destruction of the cortex of the bone and extension into the soft tissues inferior to the EAC and skull base.[8] Small cortical erosions are better seen with a CT scan. This investigation is useful in initial diagnosis; however, it has little or no role in monitoring the resolution of the disease (as shown by the findings in our case series). This is because remineralization is required before the bony changes can return to normal. However, mineralization may never occur.[5]

The MRI scan defines soft tissue involvement, including meninges and the parotid area, and is not used to detect bony changes.[5,8] The sensitivity of MRI scans was no greater than that of CT scans in regard to soft tissue findings in one of our cases. Dural enhancement and changes in the appearance of the medullary space in the bone were appreciated on MRI images and normalized after treatment. These were not appreciated on the CT scan.[8]

Therefore, MRI is useful if there is involvement of the central skull base and multiple cranial palsies. It can be complementary to CT in these cases.

Radionuclide investigations used in malignant otitis externa include planar and SPECT technetium-99m MDP bone scans, radiolabelled WBC scans, and gallium-67 imaging.

The technetium bone scan is relatively rapid, inexpensive and easy-to-perform, with a high sensitivity[9] in confirming or excluding bone infection. It also has good specificity.[10] The planar scan has relatively poor anatomical localization but SPECT imaging accurately localizes the infection site. A SPECT scan can identify early bone involvement when the CT is negative in the absence of structural destruction.[5,11] A positive bone scan is indicative of osteomyelitis. However, increased uptake on a bone scan may occasionally persist after the resolution of infection. This is because bone repair may continue long after infection has settled.

Gallium[6,7] citrate is absorbed by macrophages and the reticular endothelial cells. Although a sensitive indicator of infection, it is essentially a nonspecific technique. In the presence of infection, there is an increased uptake of gallium, which may occur in soft tissue or bone. Uptake quickly returns to normal after the infection has cleared.[5] A gallium scan with SPECT is therefore highly sensitive and is hence more accurate than a bone scan in monitoring treatment progress. The main drawback of the gallium scan is that it is relatively expensive and time-consuming.[12] A positive gallium scan in the presence of a negative bone scan probably indicates soft tissue infection only.

- **Malignant otitis externa is an uncommon condition that normally occurs in an immunocompromised or diabetic patient**
- **A recent paper in this journal (*J Laryngol Otol* 2004;118:576–9) contrasted the different imaging modes that have been used previously in this condition and concluded that MRI scanning appeared to offer distinct advantages when investigating such cases**
- **In this study, which is of three cases, radionuclide imaging was compared to CT and MRI scanning**
- **The authors conclude that CT scanning will outline the anatomical extent of the disease and that MRI scanning is useful in cases in which skull base involvement is suspected. A technetium scan also has utility if the initial CT scan is negative and a high index of suspicion remains**
- **More controversially, the authors also suggest that a technetium scan should be performed when the disease has clinically resolved and that, if it is positive, a gallium scan should be considered**

The radiolabelled WBC scan has a predilection for reticular endothelial systems. It is an expensive and laborious test, which may be negative in the presence of infection. This is due to poor counting statistics as a result of slow turnover of the labelled leukocytes. Furthermore, a negative scan does not rule out active infection.

The bone scan may be positive in the healing phase of the disease, but the follow-up scans are compared with the initial baseline positive scan and the uptake on the scan images proportionately decreases with successful treatment and the scan is negative after the

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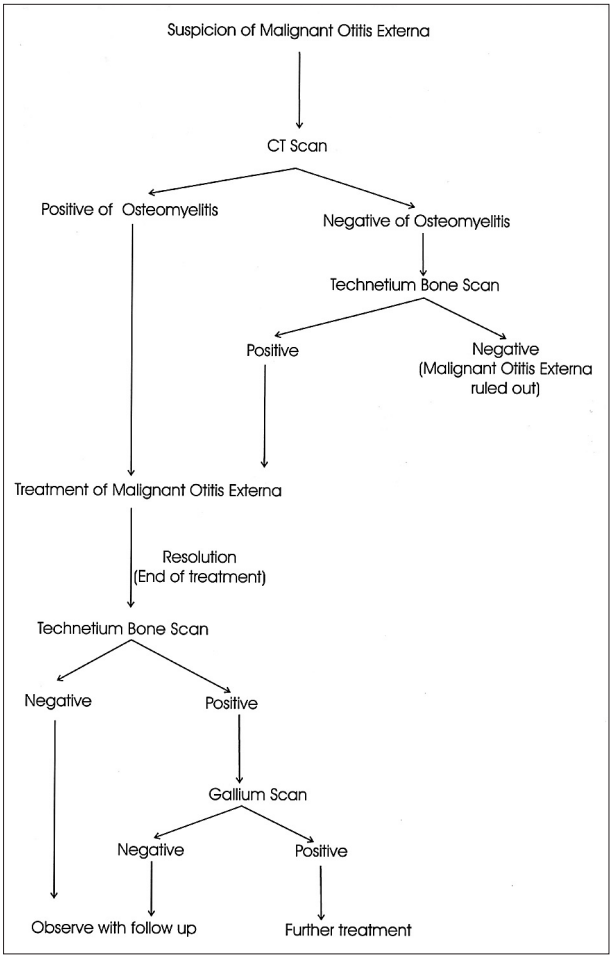

FIG. 6
Suggested investigation protocol for malignant otitis externa.

infection has been eradicated. Further information is yielded by combining the findings of the blood pool images and SPECT images, with the blood pool returning to normal followed by a decrease in bone uptake on SPECT. The multiphase bone scan has a high sensitivity for disease detection and the high-resolution SPECT bone scan images can accurately identify the site and extent of the bone disease.

In theory, the gallium scan can be used in disease monitoring; however, the cost, time, radiation dose (5 mGy for a bone scan versus 12 mGy for a gallium scan) and physical characteristics (energy) makes it relatively unattractive for clinical imaging. It would therefore be hard to justify its use for routine disease monitoring.

Conclusion

Based on our clinical experience, we suggest a protocol for optimal utilization of investigations. The protocol is summarized in a flow chart (Figure 6).

Initial diagnosis

A CT scan should be performed to determine the anatomical extent of the disease. An MRI scan should be done if there is any suspicion of skull base involvement (e.g. cranial nerve palsies). A SPECT technetium bone scan should be performed if the CT scan is negative but suspicion remains.

Disease monitoring

A technetium bone scan should be performed after completion of the course of antibiotics. If the bone scan is still positive but the infection deemed to have resolved clinically, then a SPECT gallium scan should be done. The labelled white cell scan is not recommended, as exemplified by our case series, because of pathophysiological problems causing inadequate uptake, with a resultant false-negative scan result in the presence of active infection.

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