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Radiology in Focus

Use of magnetic resonance imaging as the primary imaging modality in the diagnosis and follow-up of malignant external otitis

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Abstract
Malignant external otitis (MEO) is a severe infection of the external auditory meatus caused by *Pseudomonas aeruginosa*. Classical features include unrelenting deep otalgia, otorrhoea and granulations in the floor of the ear canal. Treatment is generally protracted antibiotic therapy and monitoring of inflammatory markers; the erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP). Traditionally computed tomography (CT) has been the imaging modality of choice. The authors present a case where magnetic resonance imaging (MRI) has been crucial in the diagnosis and follow up of a patient with MEO.

Key words: Otitis Externa; Magnetic Resonance Imaging; Treatment Outcome

Introduction

Malignant external otitis (MEO) is an infrequent but severe infective disorder, generally due to *Pseudomonas aeruginosa*, which most commonly affects elderly diabetic patients, [1] although occasional cases have been reported in immunocompetent and younger individuals.[2] The condition is characterized by a severe unilateral otitis externa, accompanied by severe otalgia, which is usually deep and throbbing, is resistant to analgesics and is worse at night; persistent drainage, and granulation tissue at the junction of the osseous and cartilaginous portion of the external ear. [3, 4]

The pathogenesis of MEO most probably depends on some underlying alterations in the immune system and the peculiar microbiological characteristics of the bacterium.[1] It has been hypothesized that in diabetics the increased virulence of bacteria in the external auditory canal is fostered by particular biochemical characteristics of the earwax, since its lower acidity, reduced concentration of lysozyme, and the augmented ratio between saturated and unsaturated fatty acids could impair local antibacterial activity.[1]

Once the organism is established in the susceptible external canal, it can spread in three directions: (1) anteriorly through the fissures of Santorini to involve the infratemporal fossa, parotid gland and facial nerve at the stylomastoid foramen; (2) posteriorly to invade the mastoid process and the vertical portion of the facial nerve; (3) medially as an osteomyelitis affecting the jugular foramen, thereby involving cranial nerves IX, X, XI and XII and possibly causing jugular venous thrombosis, brain abscess or death.[3]

The diagnosis of MEO is made on the symptomatic hallmarks, and an elevated erythrocyte sedimentation rate is the only distinctive laboratory anomaly.[5] In the literature, there is no single imaging modality to accurately evaluate the extent of the disease and the response to treatment.[4, 5] Computed tomography (CT) with the ability to delineate normal fat planes and bony cortices has been the preferred imaging modality for evaluation of necrotizing external otitis.[2] Reported experience with magnetic resonance imaging (MRI) in this disease is limited,[2] although Grandis *et al*.[2] reported that the sensitivity of MRI was no greater than that of CT in regard to the soft tissues, and suggested that MRI should be applied only as an adjunctive diagnostic study for baseline purposes in a patient with symptoms of long duration in which relapse may be more likely.[2] Karantanas *et al*.[5] studied the usefulness of CT and MRI in the evaluation of four diabetic patients with MEO and concluded that MRI was clearly superior to CT in the evaluation of early MEO, by demonstrating to better advantage the anatomical extent of the disease, but they suggested that MRI could not be used for monitoring

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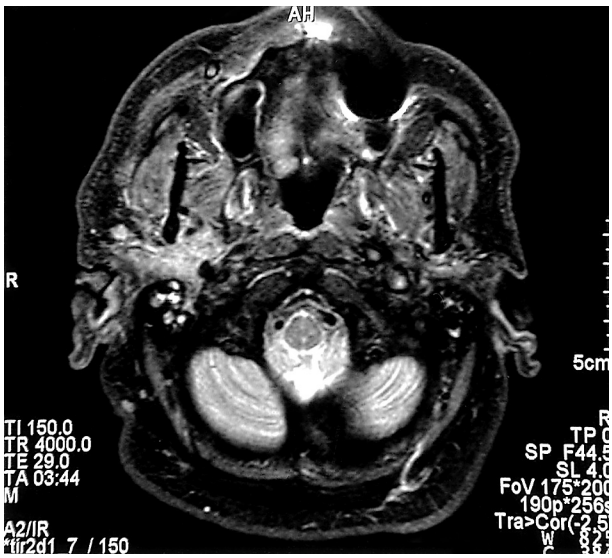

FIG. 1
MRI scan on admission.

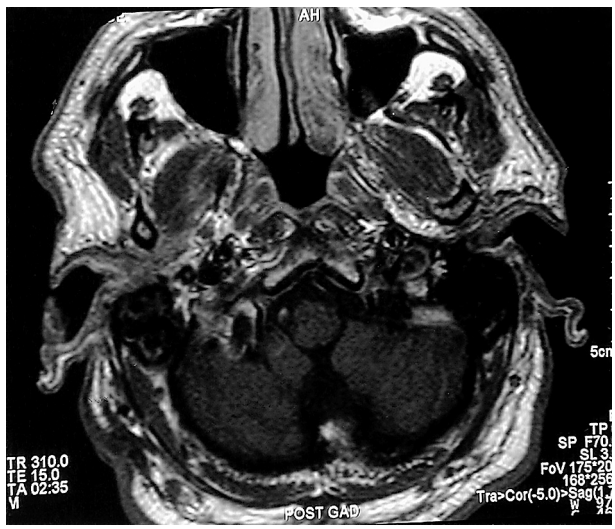

FIG. 2
MRI scan six weeks after initiation of therapy.

therapy. Both morbidity and mortality can be reduced if MEO is diagnosed early and treated aggressively,[6] the mainstay of treatment being a suitable and sufficiently protracted course of antibiotics.[1] No widely accepted algorithm exists for monitoring response to treatment.[5,6] The authors present a case report in which they have used MRI as the sole imaging modality in the diagnosis and follow up of a patient with MEO, and propose that MRI should be used as the primary imaging modality in MEO and to monitor disease progression.

Case report

A 43-year-old non-insulin dependent tablet-controlled diabetic was admitted as an emergency following a holiday abroad, having developed a severe right otitis externa. The dominant features were severe otalgia, otorrhoea and trismus. On examination extensive granulation tissue was seen in the floor of the ear canal. He was noted to have a BM of 22 on admission, an ESR of 58 and CRP of 45.4. He was also noted to have a raised white cell count and neutrophilia. He was treated with aural toilet, aural wicks, analgesia, control of diabetes and a six-week course of intravenous ceftazidime and oral ciprofloxacin. The ESR and CRP were monitored as part of his out-patient follow up.

MRI on admission demonstrated markedly thickened skin within the external auditory canal. In addition soft tissue thickening was noted around the right tympanic membrane and an extensive abnormal signal was noted within the right mastoid air cells, extending up to the level of the petrous ridge. An abnormal signal was also noted within the extracranial soft tissues extending beneath the temporal bone both anteriorly and medially into the right parotid space and the right parapharyngeal space. An abnormal signal was also noted within the right petro-occipital fissure. Loss of tissue plane definition was shown within the medial pterygoid on the right and soft tissue thickening and enhancement was noted adjacent to the right temporo-mandibular joint. Abnormal soft tissue laterally caused some effacement and medial displacement of the right internal jugular vein. These appearances are shown in Figure 1.

Following discharge the MRI scan was repeated four weeks later. The repeat scan showed the persisting abnormal enhancement around the external auditory canal, extending anteromedially into the masticator space and a trace of oedema was still present around the medial pterygoid. However, the extent of the inflammatory change was shown to be significantly less than on the previous MRI examination. Soft tissue disease within the mastoid air cell complex also appeared to be a little less extensive than before and a number of air cells were pneumatized. The middle-ear cleft also appeared to be partially pneumatized. Overall, although the inflammatory process had not completely subsided, a significant reduction in its extent, both within the mastoid and the adjacent soft tissues was noted after four weeks of antibiotic treatment, as shown in Figure 2.

The patient then underwent a further MRI scan 21 weeks after initial scanning. This showed some residual thickening of the soft tissues around the right external auditory canal but this was better defined and there had been a significant reduction in its overall extent compared with the second examination (Figure 3). Inflammatory changes within the mastoid tip were also less extensive than before. The MR appearances showed a steady improvement. This reflected the chronic resolution; the patient showed an excellent clinical recovery, with resolution of the pain and trismus. The external canal returned to a normal appearance.

Discussion

The ideal imaging modality would delineate with excellent resolution the early involvement in MEO of both bone and soft tissue at the base of the skull.[7] The ideal study would also allow the clinician to determine at which point the infection had been completely eradicated so that potentially toxic systemic antibiotics could be discontinued as soon as possible.[7]

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Several modes of diagnostic imaging have been described in the past. Plain radiography shows clouding of the mastoid air cells and bony erosion may also be demonstrated, although soft tissue spread cannot be demonstrated.[8]

Technetium[9] methylene diphosphate (Tc-99 MDP) bone scanning has been advocated as a more sensitive early diagnostic test than conventional radiology or computer assisted tomography (CAT) scanning, especially when an infectious process has invaded bone.[9] Tc-99 MDP is selectively picked up by osteoblasts and the Tc-99 bone scan becomes positive in acute osteolytic osteomyelitis well in advance of structural changes seen on transmission radiological examinations.[7] However Levin *et al.* (1984) concluded that as nine otherwise healthy patients with only external otitis presented with unexpected positive bone scans and two diabetic patients expected to have positive scans had negative scans, that a positive scan alone can be misleading, although they suggested bone scanning could add useful information in the diagnosis of progressive necrotizing MEO.[9]

- **Malignant otitis externa is a well profiled condition that is most often due to a *Pseudomonas* infection in an immunocompromised or diabetic patient**
- **This case report presents a case where MRI scanning was useful in establishing the extent of the infection as well as being helpful in monitoring the disease process**
- **The authors contrast the different imaging modes that have been used previously in this condition and conclude that MRI scanning appears to offer distinct advantages over other modalities**

Ga-67 citrate scanning is a non-specific examination and can prove positive in the presence of any inflammatory condition.[1,5] however the Ga-67 scan turns negative rapidly at the end of the disease and is useful in monitoring response to therapy.[5]

Gallium-67 SPECT imaging is of greater value than bone scans in assessing the extent of inflammatory or infectious involvement of bone.[10] Ga-67 SPECT has also been reported in one case to have been essential in the evaluation of the extent of bony involvement of the osteomyelitis associated with progressive MEO.[10]

CT scanning is currently the gold standard imaging investigation in MEO and can clearly demonstrate the progression of bone erosion once significant demineralization has occurred.[7] However, the efficacy of CT scanning is limited by the slow rate at which bone remineralizes with cure, and hence it is difficult to assess any response to therapy based on CT scanning alone.[2,7]

MRI offers submillimeter spatial resolution and axial, coronal and sagittal images are readily obtained.[7] The patient is not exposed to any ionizing radiation,

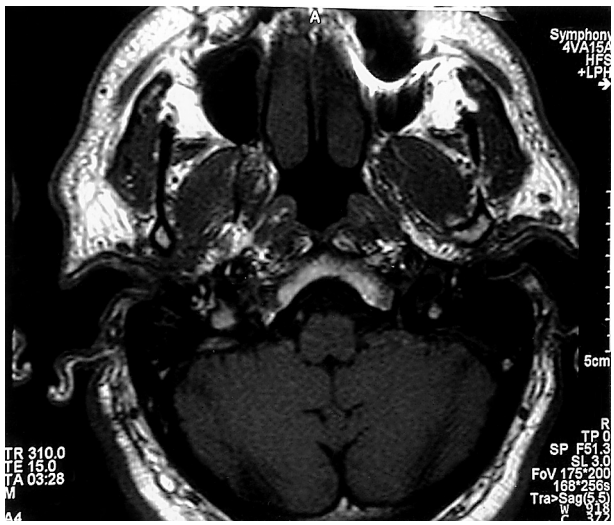

FIG. 3
MRI scan 21 weeks after therapy.

although it cannot be used in some patients with metal implants. Anatomical areas difficult to evaluate clinically such as the stylomastoid foramen, infra-temporal fossa, pterygopalatine fossa, retropharyngeal space, cranial nerves and meninges are imaged non-invasively.[5] The MRI scan also provides more detailed information about the extent of skull base and intracranial soft tissue involvement.[1] There is also the ability to detect bone marrow changes and changes in the surrounding soft tissue, the degree of enhancement and degree of response to therapy.[5] In the past MRI has not been used as the sole imaging modality for the diagnosis and follow up of patients with MEO. However, the authors suggest it has the potential for both diagnostic and follow-up imaging for MEO, and therefore can be used as the sole imaging modality for this condition. ESR and CRP measurements should also be obtained periodically in the follow-up of MEO patients.

Conclusion

The authors describe a case where MRI has been used as the sole method of imaging in the follow up of a patient with MEO. The serial scans showed improvement of the MEO. They believe MRI scanning to be a superior investigation to CT in the initial assessment of MEO and also an excellent tool for monitoring response to therapy. Further studies are needed with larger numbers of subjects for the accurate diagnosis of disease resolution,[5] with MRI scanning.

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