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Title: Usefulness of CT scans in malignant external otitis: Effective tool for the diagnosis, but of limited value in predicting outcome

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Abstract: Computerized tomography (CT) scanning is a well recognised tool for the diagnosis of malignant external otitis. To investigate the degree of correlation between CT findings scan and the patients clinical status focusing on a subgroup of patients with cranial nerve palsies. Diagnosis of malignant external otitis was confirmed in 23 patients (average age 71 years, age range 39 to 87) based on criteria of severe pain, otitis externa refractory to conventional treatments and possibly diabetes mellitus and pseudomonas detection. CT was performed on 22 of these patients. Results from these scans were analysed and correlated with patient clinical status. Retrospective analysis of CT images and medical notes were used for data analysis.The CT scans of all 22 patients showed evidence of involvement of disease outside the external auditory canal, confirming the diagnosis. Sixteen out of 22 patients (73 %) demonstrated evidence of bone erosion. Four of the 16 showed involvement of the petrous apex. From our subset of 10 patients with cranial nerve involvement, 8 demonstrated evidence of bone erosion and 2 showed mastoid and middle ear involvement without bone erosion. All 4 patients with petrous apical involvement presented with cranial nerve palsies (2 lower cranial nerve palsies, 1 seventh nerve palsy and 1 combined lower and seventh nerve palsy). CT scanning was found to be a fast and economical tool in the initial assess¬ment of patients with

malignant external otitis. Petrous apex involvement was constantly associated with cranial nerve palsies, usually the lower cranial nerves. CT findings of temporal bone in itself however were not closely correlated to the clinical outcome of the patients.

Introduction

In 1959 Meltzer and Kelemen described a case of osteomyelitis of the skull base in an elderly diabetic, the causative organism being pseudomonas [1]. Chandler in a review of thirteen patients in 1968 clinically defined the disease and used the term malignant external otitis to indicate the seriousness of the condition.

Malignant otitis externa is an infection of the temporal bone usually affecting elderly diabetic patients, which can potentially be life threatening. The causative organism is most commonly *Pseudomonas aeruginosa*, although other organisms such as *Proteus mirabilis*, *Klebsiella*, *staphylococci* and *Aspergillus fumigatus* have been isolated [2]. The infection begins in the external auditory canal and progresses into the temporal bone and other structures in close proximity [3]. Continued extension of this infection can lead to skull base osteomyelitis.[4]. Symptoms and signs may include severe otalgia, otorrhoea, and involvement of various cranial nerves. Most patients are elderly and have diabetes mellitus or other immunocompromising conditions. The reason that elderly diabetics are most at risk is thought to be related to microangiopathy of the ear canal in this group of patients [5, 6].

Determining the anatomical extent of the disease and evaluating the physiological response to therapy can be challenging. This is of clinical importance in terms of assessing the progress of the disease and also possibly in knowing at what point antibiotic therapy can be stopped. This is where the role of imaging can be useful, but there is as yet no single imaging modality, which answers both of these questions [7]. An ideal form of imaging would show early extent of both

bone and soft tissue involvement and would also provide information further down the line as to when the infection has been eradicated.

At present clinicians rely upon Computerized Tomography (CT), Magnetic Resonance Imaging (MRI) and radionucleotide imaging as the primary modalities of investigation in malignant otitis externa. CT and MRI both provide information on inflammatory changes in the soft tissues of the middle ear, mastoid, infratemporal fossa, parapharyngeal space and the area around the stylomastoid foramen [8]. In addition CT also shows the presence and progression of bone erosion. MRI however is superior to CT scanning in evaluating soft tissue disease [9]. Radionucleotide imaging includes both technetium and gallium scanning. Technetium and gallium scanning may be useful in early detection of the disease and is positive before radiologically apparent changes occur [10]. The precise anatomical location of the disease cannot, however, be accurately assessed with both these techniques and subtle disease extension cannot be detected.

We report on the use of CT scanning in malignant external otitis in relation to its findings, particularly of bone erosion. We then correlate these finding to clinical outcome and prediction of morbidity, such as cranial nerve palsies and mortality.

Material and Methods

A retrospective case review of 23 consecutive patients with a diagnosis of malignant external otitis based on criteria of severe otalgia, otitis externa refractory to usual treatments, CT evidence of disease involvement outside the external auditory canal and usually though not essentially, diabetes mellitus and microbiological evidence of pseudomonas culture. The average age of patients was 71 years, with an age range 39 to 87 years. The medical records and imaging of all patients were analysed and the information collected onto a database.

Results

Out of the 23 patients, 19 were male and 4 female. All patients had severe ear pain and were refractory to usual treatments for otitis externa. Twenty-one patients had a pre-existing diagnosis of diabetes mellitus. None of the patients had any other form of immunocompromise. Eighteen patients had documented microbiological evidence of pseudomonas ear swab culture. From the 5 remaining, 2 had no growth, 1 grew group F streptococcus, 1 enterococcus faecalis and mixed anaerobes and the last patient grew alcaligeneous xylene oxidans.

All 23 patients underwent CT scanning at the time of initial diagnosis. In all of these patients, there was evidence of spread of the disease to outside the external auditory canal. Overall, 7 patients showed evidence of involvement of the disease around mastoid and middle ear, but with no evidence of bone erosion. Sixteen patients

showed radiological evidence of bone erosion in a variety of locations with one of these patients also having intracranial involvement in the form of a sigmoid sinus thrombosis. (Table 2). The anatomical location of the bone erosion from the 16 cases was; 5 affecting the bony external auditory canal, 7 with additional spread to also involve the mastoid or middle ear and 4 with extension to involve the petrous apex. Table 1 shows a summary of CT scan findings.

From our subgroup of 10 patients with cranial nerve palsies, 8 showed evidence of bone erosion on CT scan (Fig. 2). Four out of those 8 patients (50%) had bone erosion at the mastoid or around middle ear whereas in the other 4 patients, the erosion involved the petrous apex. The remaining 2 patients from our group of 10 with cranial nerve palsies, showed no evidence of bone erosion; instead soft tissue involvement of disease around middle ear or mastoid was demonstrated. Of note, from our series, all 4 patients with bone erosion at the petrous apex had cranial nerve palsies. Two had lower cranial nerve palsies (IX, X, XI XII), 1 had VII nerve palsy and the final one had a combined lower cranial nerve, VI and VII nerve palsy.

Sixteen patients had bone erosion according to CT scan findings. In total 8 (50%) of these patients had a cranial nerve palsy. Five were seventh nerve palsies, 2 were lower cranial nerve palsies, (X and combined X and XII nerve palsy. The remaining case had both a seventh and lower cranial nerve palsy.

Technetium bone scanning was performed in 16 of the 22 patients; all were positive showing increased tracer uptake in the temporal bone of the affected side.

There was no mortality directly attributable to malignant external otitis in our series. As patients were mostly elderly diabetics, mortality occurred from other causes. Morbidity directly related to malignant external otitis was due to non-resolution of cranial nerve palsies. Of the 7 out of 10 patients with non-resolution of cranial nerve palsy, 6 had bone erosion on CT. Though of the 3 with resolution of palsy, 2 had bone erosion.

Petrous apical involvement was always associated with cranial nerve palsy, usually the lower cranial nerves. Generally CT findings of temporal bone erosion in itself were not closely correlated to the clinical presentation of the patients.

Discussion

CT scanning has limitations, we have previously mentioned the superiority of MRI in delineating soft tissue disease in malignant external otitis. Bone erosion is only demonstrated on CT once bone demineralisation has occurred [11]. This is not usually until some months into the disease. Therefore in the early stage of ostemyelitis before bone demineralisation, there may be no bony changes seen on CT [12]. Furthermore once bone demineralisation has occurred a CT scan rarely returns to normal thus making its use for monitoring response to therapy and length of time of antibiotic treatment, limited [13, 14, 15]. It is also difficult to differentiate other diseases of the temporal bone, such as carcinoma, from malignant otitis externa solely on the basis of CT.

The finding of bone erosion in itself appears to be a relatively non-specific sign in terms of its value. Sixteen (70%) of our 23 patients had this finding on CT. Although it was useful in confirming clinical suspicion of infection, it did not yield a predictive value in terms of severity of disease or outcome, as in this group of patients 8 (50%) presented with cranial nerve palsies and 8 (50%) without.

Anatomical location of bone erosion should in theory be of greater predictive value, especially in determining the cranial nerve we may expect to be involved or at risk. In bone erosion involving the mastoid or middle ear, we would expect seventh nerve involvement and in involvement of the petrous apex, the lower cranial nerves from nine to twelve, along with the sixth nerve, may be involved. Certainly, from our series we found that not all with mastoid or middle ear bone erosion had a seventh nerve palsy, but when a cranial nerve was involved, which was in 4 out of 7 (57%) cases, it was always the seventh. Even more convincing is petrous apex bone erosion. Of the 4 cases in which this occurred, 3 had involvement of lower cranial nerves, one of these being a combined seventh and lower cranial nerve palsy and one had a solitary seventh nerve palsy. Interestingly the patient with the combined palsy also had bilateral sixth nerve palsies. In all cases in which there was petrous apex erosion there we were able to confirm CT evidence of mastoid or middle ear bone erosion.

Eventual outcome in terms of mortality was the same between groups, as there were no deaths directly attributed to malignant external otitis in our series. However the group with palsies fared worse in morbidity with 6 out of the 8 although being clear of infection, having persistent cranial nerve palsy.

Our series has shown that the presence of bone erosion on CT does not help particularly in the prediction of outcome. However the anatomical location of the bone erosion can be of some use and in particular involvement at the petrous apex in our series meant a 100% probability of cranial nerve involvement. As cranial nerve palsies are a clinical rather than radiological entity the role of CT scanning in malignant external otitis, with the advent of MRI, is limited [11]. Its role is largely related to determining the anatomical extent of the disease and possibly in disease progression.

Conclusion

Temporal bone CT findings were not closely correlated to the clinical presentation and outcome in our series of 23 consecutive patients. Petrous apex involvement was at all times associated with cranial nerve palsy, usually the lower cranial nerves. CT is a fast and economical tool for confirming the diagnosis of malignant external otitis but has limited value in predicting outcome.

References

1. Schuknecht HF (1993) Pathology of the ear. 2nd ed. Philadelphia: Lea & Febiger, 220–223

2. Sudhoff H, Linthicum FH Jr (2003) Malignant external otitis: temporal bone histopathology case of the month. Otol Neurotol 24:346-347

3. Meltzer PE, Kelemen G (1959) Pyocyaneous osteomyelitis of the temporal bone, mandible and zygoma. Laryngoscope 69:1300–1316

4. Chandler JR (1968) Malignant external otitis. Laryngoscope 78:1257–1294

5. Slattery WH 3rd, Brackmann DE (1996) Skull base osteomyelitis. Malignant external otitis. Otolaryngol Clin North Am 29:795–806

6. Rowlands RG, Lekakis GK, Hinton AE (2002) Masked pseudomonal skull base osteomyelitis presenting with bilateral Xth cranial nerve palsy. J Laryngol Otol 116: 556–558

7. Chole, RA, Sudhoff, H (2005) Acute and chronic otitis media and mastoiditis, in: Otolaryngology, Head and Neck Surgery, ed. 4 by Charles Cummings, MD, Paul Flint, MD, Lee Harker, MD, Bruce Haughey, MD, Mark Richardson, MD, Thomas Robbins, MD, David Schuller, MD and Regan Thomas, MD, Elsevier Mosby, 2988-3012

8. Levenson MJ, Parisier SC, Dolitsky J, Bindra G (1991) Ciprofloxacin: drug of choice in the treatment of malignant external otitis (MEO). Laryngoscope 101:821-824

9. Amorosa L, Modugno GC, Pirodda A (1996) Malignant external otitis: review and personal experience. Acta Otolaryngol Suppl 521:3–16

10. House JW, Brackmann DE (1985) Facial nerve grading system. Otolaryngol Head Neck Surg 93:146-147

11. Rubin Grandis J, Branstetter BF, Yu VL (2004) The changing face of malignant (necrotising) external otitis: clinical, radiological, and anatomic correlations. Lancet Infect Dis 4:34-39

12. Sreepada GS, Kwartler JA (2003) Skull base osteomyelitis secondary to malignant otitis externa. Curr Opin Otolaryngol Head Neck Surg 11:316-323

13. Rubin J, Yu YL (1988) Malignant external otitis: insights into pathogenesis, clinical manifestations, diagnosis, and therapy. Am J Med 85:391–398

14. Berenholz L, Katzenell U, Harell M (2002) Evolving resistant pseudomonas to ciprofloxacin in malignant otitis externa. Laryngoscope 112:1619-1622

15. Grossman RF (1997) The role of fluoroquinolones in respiratory tract infections. J Antimicrob Chemother 40 Suppl A:59-62

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Figures

Fig. 1

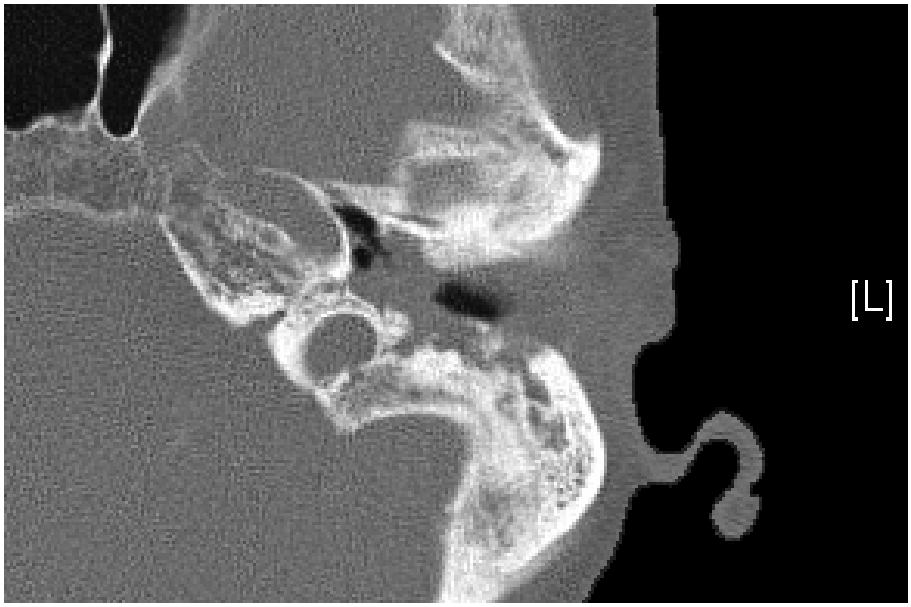

Fig. 2

Fig.1 Computed tomography of the left temporal bone showing a 62 year old male diabetic patient with a bone erosion adjacent to the left external ear canal. No cranial nerve palsies were present. The petrous apex is not involved.

Fig.2 Computed tomography of the temporal bones with right malignant external otitis petrous apex involvement (arrow) in an 85 year old diabetic male patient. Right cranial nerve palsies of IX, X, XI XII were present.

Table 1: Findings of CT scans

Finding	**Number**
Involvement of disease outside external auditory canal	22
Involvement outside external auditory canal, but no evidence of bone erosion	6
Evidence of bone erosion	16
Bone erosion of bony external auditory canal	5
Bone erosion involving mastoid/ middle ear	7
Bone erosion involving petrous apex	4
Itracranial involvement	1

Table 2: Relation of CT findings with cranial nerve palsies.

	CT scan findings		
	Bone erosion	No bone erosion	Total
Cranial nerve palsies	8	2	10
No Cranial nerve palsies	8	5	13
Total	16	7	23