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Imaging for cochlear implants

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Abstract

All patients in the Birmingham Cochlear Implant Programme underwent computerized tomography (CT) scanning and were assessed and images interpreted by the main author. Of the first 100 cases, 20 were considered to have abnormalities of the inner ears by CT imaging. It is concluded that the commonest abnormality was cochlear otospongiosis followed by labyrinthitis ossificans.

Otospongiosis is well shown by CT which gives a good predicator of luminal patency.

However, labyrinthus obliterans, although usually apparent on CT, is not reliably shown in all cases and T2 weighted magnetic resonance imaging (MRI) is better.

Key words: Cochlear implants; Tomography, X-ray computed; Otosclerosis; Cochlea; Labyrinthitis ossificans

Introduction

The first 100 adult patients assessed and implanted on the Midland Adult Cochlear Implant Programme were retrospectively reviewed for the CT findings. All patients underwent a CT examination as part of the assessment and all reports were issued by one radiologist.

Results

Of the first 100 cases, 20 were considered to have abnormalities of the inner ears as shown by imaging (Table I). One patient (patient B) had bilateral transverse fractures of petrous pyramids and another (patient I) large vestibular aqueducts. Both these patients had full length insertion of the implant. On audiological performance testing at nine months post-implant, patient B performed poorly whilst patient I achieved open-set speech recognition.

Otospongiosis of the cochlear capsule was identified in nine patients and full insertion of the electrode was achieved in four. In the other five cases there was partial insertion (Figure 1). In one of

TABLE I
CT FINDINGS AND SURGICAL OUTCOME

Patient	CT findings	Surgical outcome	No. of electrodes
A	R. narrow basal turn. L. more severe lab. oss. of cochlea and vestibule.	R. implant half way, 15mm.	15
B	R. transverse # vestibule. L. # jugular fossa.	L. implant full length.	22
C	Diffuse otospongiosis.	Implant full length.	22
D	Diffuse otospongiosis.	Implant full length.	22
E	Severe otospongiosis.	"New bone'. Partial insertion to half way.	10
F	Severe lab. oss..	Totally obliterated "new bone". Implant in 3mm.	7
G	R. minor lab. oss., basal turn only.	L. implant full length.	22
H	Bilateral diffuse otospongiosis.	L. implant full length.	22
I	Bilateral large vestibular aqueduct.	L. implant full length.	22
J	L. lab. oss.	R. implant to half way.	
K	Normal CT.	L. implant to ✆ way.	
L	Bilateral lab. oss. – distal coils of cochlea and vest.	L. implant to ✂ way.	
M	R. some narrowing of basal turn.	L. full insertion.	22
N	Severe bilateral otosclerosis/otospongiosis.	R. implant to half way. "Partly patent, fibrous for 3mm".	19
O	Severe bilateral otospongiosis.	Fully patent.	22
P	Bilateral narrowing of basal turn.	R. fully implant.	22
Q	Bilateral severe otosclerosis/otospongiosis.	R. partial insertion, "5mm, new bone".	13
R	Bilateral slight lab. oss., worse on L.	Totally obliterated "new bone".	0
S	R. otosclerosis/otospongiosis.	Implant to half way, partially patent.	16
T	Cochlear and fenestral otosclerosis.	Fully patent.	22

R. – Right ear; L. – Left ear; Lab. oss. – Labyrinthitis ossificans.

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FIG. 1

Axial CT of the petrous temporal bones in a patient with otospongiosis. The arrow indicates the abnormal rarefied bone around the cochlear coils on the right. An electrode array has been partially inserted into the basal coil on the left.

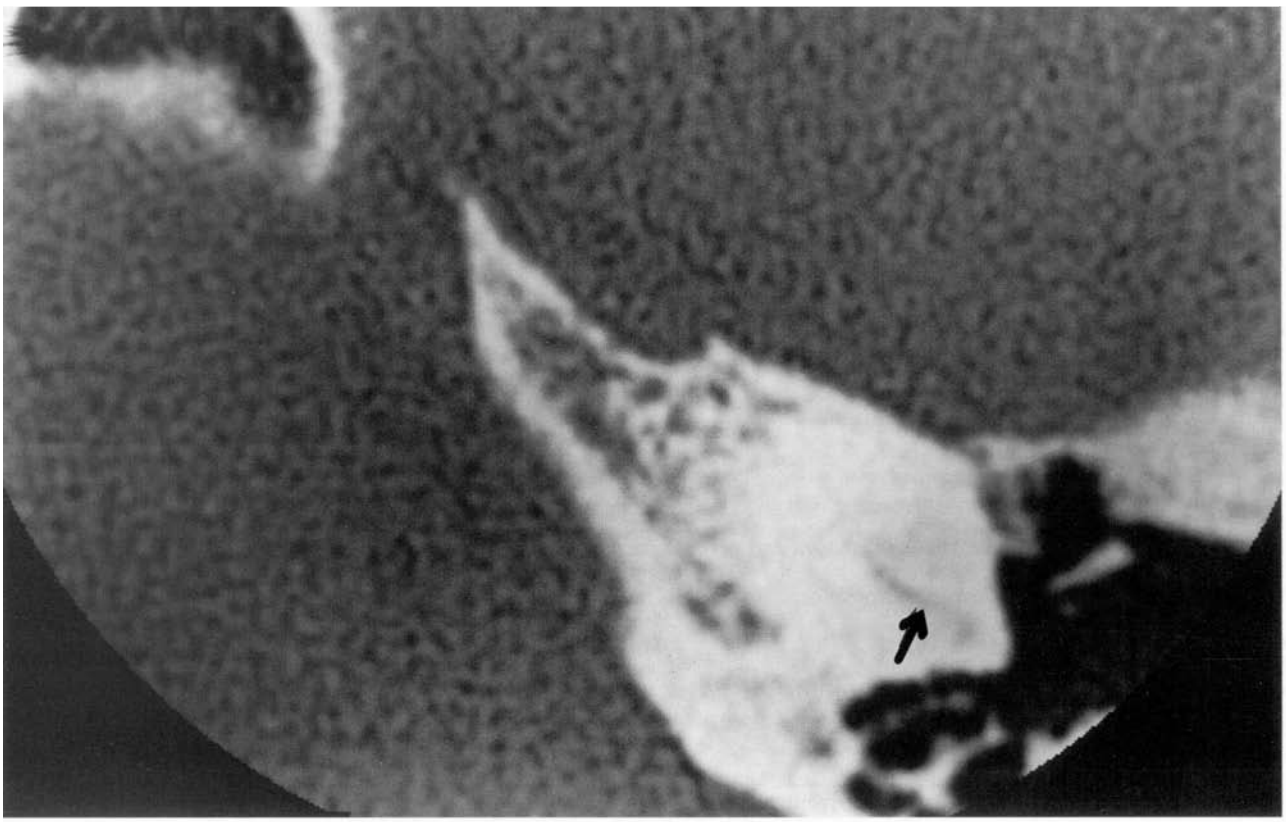

FIG. 2a

Axial CT of the inner ear showing severe labyrinthitis obliterans (arrow). A vague outline of the first one and half cochlear coils can be identified ➔.

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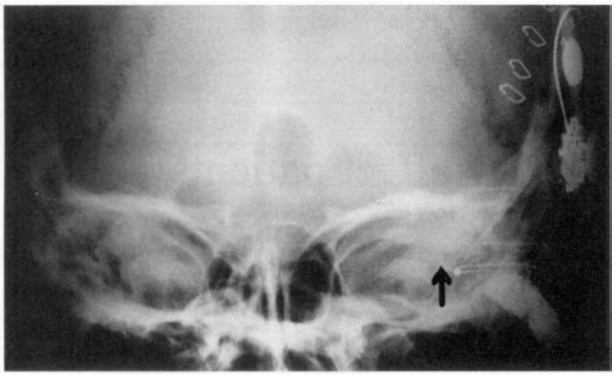

FIG. 2b

Transorbital plain film view after implantation showing only partial insertion of the electrode array (arrow).

these patients the electrode array was inserted 'half way' but a subsequent operation on the other ear resulted in full insertion.

Labyrinthitis obliterans, sclerosis and/or ossification affecting the lumen of the labyrinth was present in seven ears, as shown by CT, but probably in one other patient where the array could only be inserted partially and in another similar case where labyrinthitis obliterans had been predicted in one ear but only partial insertion was achieved in the apparently normal ear (patients J and K). In both of these cases CT presumably had failed to demonstrate the obliteration. In one case of severe obliteration (patient F) the array could only be inserted for 3 mm (seven electrodes) and the result was poor (Figure 2). Another case (patient R), with severe obliteration in one ear and only some narrowing of the basal turn in the other, could only be implanted halfway (15 electrodes) (Figure 3).

In addition there were an extra six patients in whom there was failure to gain full insertion. Some of these may have been due to surgical technical error but the impression was gained in some that there was a soft tissue obstruction within the lumen that was unanticipated because of the normal computerized tomogram.

Conclusion

Otospongiosis is well shown by CT if the otospongiotic bone does encroach upon the cochlear lumen then the surgeon may notice no abnormality. A full electrode insertion and a good result can be expected. This happened in four patients. In the other five patients with otospongiosis there was an extension of the pathologic bone into the cochlear lumen and full insertion was not possible.

Labyrinthitis obliterans was seen on CT as varying degrees of sclerosis in the cochlear coils with narrowing of the basal turn as the commonest feature. However, CT does not seem reliable for showing all cases of labyrinthitis obliterans, probably T2 weighted MRIs are necessary for confirming the formal presence of fluid in the cochlear coil.

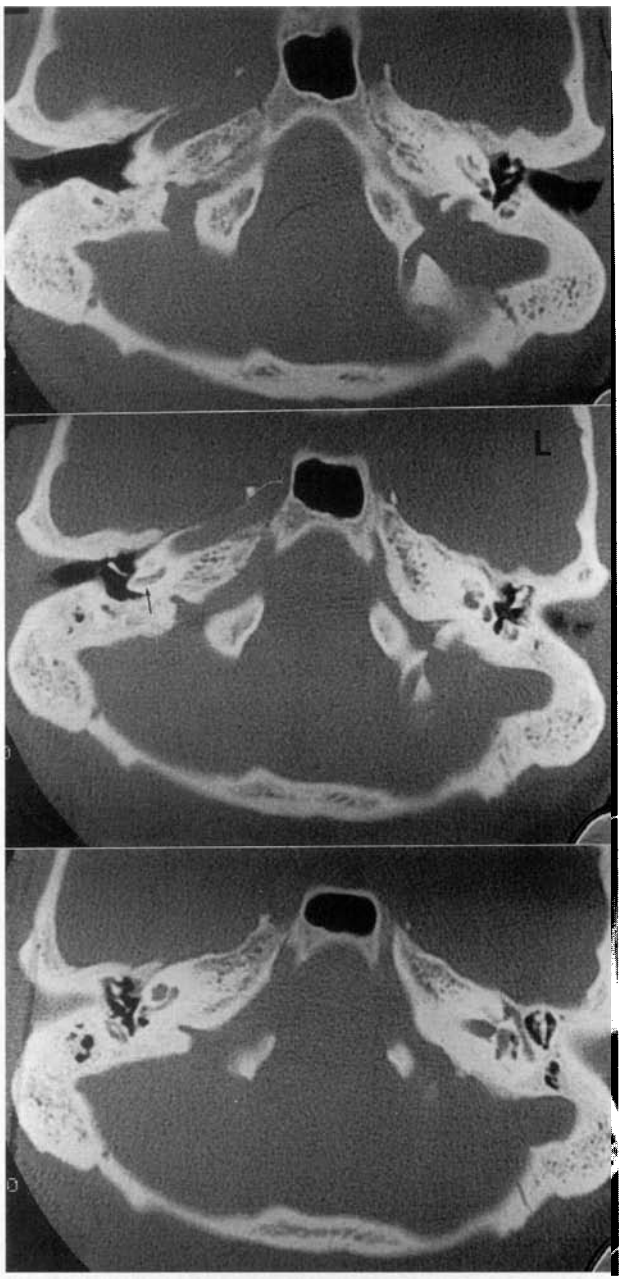

FIG. 3

Serial axial CT sections showing severe labyrinthitis obliterans on the left; less severe on the right but with some narrowing of the basal turns. Nevertheless "total obliteration by new bone" was found on the right and implantation was only achieved about halfway after drilling.

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