

Computed tomography in suppurative ear disease: does it influence management?

A. BANERJEE, F.R.C.S.(ED.), M.S., D.N.B., L. M. FLOOD, F.R.C.S., P. YATES, F.R.C.S.(ED.), K. CLIFFORD, F.R.C.R.*

Abstract

The value of high resolution computerized tomography (CT) prior to routine mastoid surgery for cholesteatoma remains controversial. Doubts about sensitivity and specificity, in detecting the extent of underlying pathology and in predicting asymptomatic complications, prevent widespread adoption.

This retrospective study looks at the influence of pre-operative scanning on the surgical management of chronic suppurative otitis media over an 18-month period. The radiological findings determined the choice of surgical approach, but contributed less to the decision to operate and the prediction of potential hazards. CT is of most value when the otologist can be flexible in surgical technique, tailoring it to imaging findings.

Key words: Tomography, X-ray Computed; Temporal Bone; Cholesteatoma

Introduction

High resolution computed tomography (CT) can undoubtedly provide reliable details of temporal bone anatomy and its congenital variations. Evidence of location and extent of disease and of asymptomatic complications, secondary to bony destruction, should also influence management. However, there are concerns that CT cannot reliably distinguish cholesteatoma from mucosal disease and that it lacks a guaranteed sensitivity for erosive complications. Such concerns have cast doubts on its value. Moreover, it is argued that CT is irrelevant and expensive, as surgical exploration must still anticipate undetected hazards and will ultimately reveal them. This study examines an individual experience of the influence on management of CSOM from routine pre-operative CT scanning.

Materials and methods

All patients presenting to a single otologist, with otoscopically evident cholesteatoma or a chronic tympanic membrane perforation and refractory otorrhoea, over an 18-month period (October 1998–March 2000 inclusive) underwent CT scanning of the temporal bones, where feasible.

Our scanning technique and systematic interpretation of the films has been described in a previous article.¹ Routine scanning of the middle ear, with a Philips single slice scanner, employed coronal images

of a prone patient, without intravenous contrast. The parameters applied included: a 512 matrix, a 250 field of view or zoom, a four second scan time; 1.5 mm contiguous slices, a 1H filter (edge enhancement), 120 kV, 100 mA exposure, and 25 slices per examination.

A single radiologist provided all reports and, at clinic review, all patients were seen by one author to discuss the management options. With few exceptions, they were seen in a dedicated otology clinic, where all patients are allocated a 20-minute review appointment. A thorough review of the findings allowed demonstration of the anatomy and pathology and formulation of the surgical plan. Identification of the course of the facial nerve and the position of the inner ear, proved a useful introduction to discussion of the operative risks. The films were presented as providing a map, an obvious advantage in any exploration. All surgery was performed by, or under, direct supervision of one consultant and operative findings recorded on a standard proforma including:

- (1) presence of cholesteatoma and the location and extent of the disease;
- (2) erosion of ossicles;
- (3) erosion of tegmen or dural exposure;
- (4) exposure of the facial nerve;
- (5) dehiscence of the lateral semicircular canal;
- (6) restriction of access to the attic by a low lying dura.

From the Department of Otorhinolaryngology, North Riding Infirmary, Middlesbrough and the Department of Radiology*, James Cook University Hospital, Middlesbrough, UK.

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TABLE I
SURGICAL MANAGEMENT OF CSOM GUIDED BY CT SCANNING

Total scans performed for CSOM		59
Cholesteatoma	43	
Tubotympanic disease	16	
Subsequent management		
<i>Cholesteatoma operations</i>		33
Atticotomy	3	
Atticoanostromy	5	
Modified radical mastoidectomy	10	
Combined approach tympanoplasty	11	
Cavity revision	4	
<i>Non-cholesteatoma operations</i>		6
Myringoplasty	1	
Myringoplasty + ossiculoplasty	1	
Cortical mastoidectomy	2	
Cortical mastoidectomy + myringoplasty	2	

These surgical findings were then correlated with a subsequent review of the films to a standardized protocol,² by two observers, blinded to the surgical findings.

Results

During the 18-month study period, 66 patients under the care of one otologist underwent temporal bone CT scanning. Of these scans, 59 were to investigate either cholesteatoma (43 patients) or tubo-tympanic disease presenting with otorrhoea refractory to medical treatment where cortical mastoidectomy might be considered (16 patients).

Thirty-nine operations resulted; 33 were for cholesteatoma and six for non-cholesteatomous CSOM (Table I). Ten further patients with clinically evident cholesteatoma did not come to surgery. Two patients defaulted from follow-up and three remained on the waiting list over six months due to their postponing surgery. In three patients, with long-standing symptoms and a small, uncomplicated cholesteatoma in a sclerotic mastoid, concerns about fitness for anaesthesia were felt to outweigh the risks of the disease. In two further patients similar radiological findings, in one better-hearing and one only-hearing ear, led to a mutual decision for conservative management. During this study period at least, all cholesteatoma operations were completed as planned.

Correlation of CT information with surgical findings was only possible in those procedures providing sufficient exposure (Table II). Dural height and, hence ease of access to the attic, was correctly predicted in 26 of 39 procedures. In 12 patients low lying dura, lateral to the middle-ear cleft, was predicted but the surgeon felt it had not significantly compromised the approach. Dural exposure due to tegmen erosion was predicted in six scans but only noted in three subsequent operations. In one further exploration an unexpected defect exposed the middle fossa dura. Lateral semicircular canal dehiscence was suggested in four scans, but could only be confirmed in one operation, as the matrix was not elevated when this complication was suggested by the scan and cochlear function was still present. Ossicular erosion or preservation was correctly anticipated in 32 of 39 procedures. A major facial nerve dehiscence was

TABLE II
CORRELATION OF CT INTERPRETATION WITH SURGICAL FINDINGS
(39 CASES)

Dural height			
Correlated	26		
Not correlated	13		
		findings better at surgery	12
		access worse at surgery	1
Dural exposure			
Correctly predicted (true +ve)	3		
Not correlated	4		
		seen only on scan (false +ve)	3
		seen only at surgery (false -ve)	1
Lateral semicircular canal erosion			
True positive	1		
Not correlated (? false +ve)	3		
Ossicle integrity/erosion			
Correctly assessed (true +ve/true -ve)	32		
Not correlated	7		
		seen only on scan (false +ve)	1
		seen only at surgery (false -ve)	6
Facial nerve dehiscence			
Possibly eroded	25		
Major exposure	1		
Intact	13		

unequivocally demonstrated in one scan, but suggested in 25. In only 13 scans could integrity of the bony canal be assured.

Discussion

Curiously, this largely retrospective review may better illustrate custom and practice than the traditional prospective study. The latter allows an estimate of sensitivity and specificity for any diagnostic investigation, but the gold standard for comparison, in this case, is the highly subjective surgeon's view of the per-operative findings, e.g. ease of access. An operator cannot ethnically be blinded to the outcome of pre-operative imaging.

The purpose of this project is to instead examine an arbitrary 18-months experience of routine CT scanning prior to planned surgery of active middle-ear sepsis. It does not claim to provide scientific evidence of value as a diagnostic tool. Indeed, no outcome measures of benefit are offered to justify management decisions. This review illustrates, nonetheless, that the information provided by CT can influence a receptive and flexible surgeon, who is familiar with the radiology of the temporal bone.

Choice of surgical approach

Foreknowledge of anatomy guided surgical technique and best illustrated the value of pre-operative imaging. Figures 1, 3 and 5 are all sections of the same plane through the cochlea and malleus, yet demonstrate very different lateral anatomy. Figures 2, 4 and 6 are the corresponding posterior slices and show a wide variation in mastoid appearance.



FIG. 1

Coronal section demonstrating left cochlea, facial nerve superiorly, malleus in opaque tympanic cavity and favourable lateral access to the attic.

Of the 29 primary operations, approximately one third were planned (and all completed) as intact canal wall/posterior tympanotomy procedures, encouraged by favourable mastoid pneumatization (Figures 1–4). A further one third, anticipating limited access, underwent modified radical mastoidectomy, assured of a small residual cavity. In all of the remaining eight cases, a limited exposure (atticotomy/atticoantrostomy) was correctly anticipated for a localized sac (Figures 5, 6). However this last finding has not been the authors' universal experience. CT cannot reliably differentiate chole-



FIG. 2

More posteriorly, a cellular but largely opaque mastoid system. The descending facial nerve (arrowed) is seen beneath the posterior limb of the lateral semicircular canal.



FIG. 3

In contrast to Figure 1, the right dura is lower lying, restricting attic access.

teatoma from mastoid effusion or mucosal disease, secondary to failed ventilation. It may, therefore, underestimate the extent of the sac.

Prediction of complications

Correlation of CT interpretation and surgical findings is compromised here by a cautious surgical management of any suggested complications. If cholesteatoma matrix is not elevated off a suspected labyrinthine fistula, then surgical verification of the defect, suggested by CT, is impossible. The apparently low specificity then merely reflects a surgical



FIG. 4

Posteriorly there is a well developed mastoid system with septa largely intact, presenting excellent access for an intact canal wall procedure.



FIG. 5

The scutum is eroded and the malleus largely resorbed. High dura gives good access for atticotomy.



FIG. 7

High dura ensures easy access to the antrum, which reveals a fistula of the lateral semicircular canal (arrowed).

decision to avoid tampering with the area of potential hazard. Of four patients reported as showing erosion of the lateral semi-circular canal, only one was surgically verified, in an ear with a significant sensorineural loss. In patients with preserved cochlear function, reported as showing a fistula, the matrix over the canal dome was preserved and exteriorized in an open cavity (Figures 7, 8). Even if cholesteatoma is elevated, thinning, rather than dehiscence, of the lateral wall of the canal may not be apparent. Accurate assessment of such a fistula requires both coronal and axial images. Little attempt was made to confirm minor dehiscences of the facial nerve (Table II), it being safer to assume

that every Fallopian canal is so exposed when dissecting off the cholesteatoma. Studies which criticize sensitivity and specificity are unfortunately dated³ and employ axial scanning techniques.^{3,4} More recent work suggests that modern techniques show excellent radiosurgical correlation for the status of the malleus, stapes and lateral semicircular canal, less accuracy for the incus and tegmen, but poor results for the facial nerve.⁵ The thin bone overlying the facial nerve and that forming the tegmen plate is difficult to assess because of partial volume averaging with adjacent soft tissue.



FIG. 6

A small antral cavity and sclerotic mastoid favours the small-cavity, atticostomy approach.



FIG. 8

More posteriorly, the dense sclerotic mastoid and small antral cholesteatoma suggest an atticostomy technique, rather than a challenging transmastoid approach.

CT should not be seen as indispensable but, rather, as a useful aid to management. Notably, four mastoid explorations were not preceded by CT in this study period, three in children who would have required sedation/anaesthesia and one in an adult emergency presentation. In the patients managed conservatively, medical or social factors proved the deciders rather than imaging findings. However, the principal surgeon continues to routinely employ scanning despite these findings.

- **This is a study on the value to the surgeon of pre-operative CT scanning of the ear in attico-antral and tubotympanic disease**
- **The study is a retrospective correlation of the value of scanning in predicting complications as well as a study of its value in the choice of surgical approach**
- **Scanning helped predict the type of operation to perform but the authors point out that this should be interpreted with caution as cholesteatoma cannot be distinguished from an effusion or mucosal disease**
- **Scanning was not reliable at predicting bone loss over the facial nerve and tegmen tympani**
- **The authors conclude that CT scanning has limitations but that it is a useful adjunct to management**

The advent of multi-slice spiral CT with more sophisticated post-construction software will theoretically provide isotropic re-constructions in any chosen plane.⁶ The challenge to the surgeon will continue to be to adapt technique to the better information provided and still to proceed with caution and traditional skills, anticipating the unexpected.

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Address for correspondence:
Mr L. M. Flood,
Consultant ENT Surgeon,
c/o ENTER,
North Riding Infirmary,
Newport Road,
Middlesbrough, TS1 5JE, UK.

Fax: 01642 231154
E-mail: enter@onyxnet.co.uk

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