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MAIN ARTICLE

Interpreting pre-operative mastoid computed tomography images: comparison between operating surgeon, radiologist and operative findings

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Abstract

Objectives: This study aimed to compare the interpretations of temporal bone computed tomography scans by an otologist and a radiologist with a special interest in temporal bone imaging. It also aimed to determine the usefulness of this imaging modality.

Methods: A head and neck radiologist and an otologist separately reported pre-operative computed tomography images using a structured proforma. The reports were then compared with operative findings to determine their accuracy and differences in interpretations.

Results: Forty-eight patients who underwent pre-operative computed tomography scans in a 30-month period were identified. Six patients were excluded because complete operative findings had not been recorded. Positive and negative predictive values and accuracy of the anatomical and pathological findings were calculated for 42 patients by both reporters. The accuracy was found to be less than 80 per cent, except for identification of the tegmen and lateral semicircular canal erosion. Overall, there was no significant difference in interpretations of computed tomography scans between reporters. There was a slight difference in interpretation for tympanic membrane retraction, facial canal erosion and lateral semicircular canal fistula and/or erosion.

Conclusion: Pre-operative computed tomography scanning of the temporal bone is useful for predicting anatomy for surgical planning in patients with chronic otitis media, but its reliability remains questionable.

Key words: Temporal Bone; Mastoid; Tomography; X-Ray Computed; Cholesteatoma

Introduction

Temporal bone computed tomography (CT) scanning is considered a valuable tool for planning the surgical approach and predicting disease extent chronic otitis media. However, its exact role in the pre-operative assessment remains controversial.[1,2] CT images are normally reported by a radiologist, but the operating surgeon also reviews them prior to surgery. The surgeon then obtains immediate feedback about his interpretation during the procedure. In contrast, surgical findings are rarely fed back to the radiologist who provided the original CT report. In view of the different approaches and training backgrounds of the surgeon and radiologist, there will inevitably be some differences between the two interpretations. Identifying these differences and comparing them with the definitive diagnosis established during surgery provides an effective evaluation method and a positive learning experience for both clinicians.

This study aimed to assess the accuracy of CT scan findings for predicting temporal bone anatomy, disease extent and any potential complications such as facial nerve dehiscence. It also aimed to compare the findings of an otologist and a radiologist with a special interest in temporal bone imaging. This was done using a structured reporting system, thus providing a learning experience for both clinicians and helping to enhance the quality of future reporting.

Materials and methods

A review was conducted of 48 consecutive patients who underwent mastoid operations performed by a single otologist over a 30-month period. A radiologist with a special interest in temporal bone imaging and the surgeon who performed the procedures retrospectively reported all pre-operative temporal bone CT scans. The reporting was recorded systematically using a structured proforma (see Appendix 1). Both

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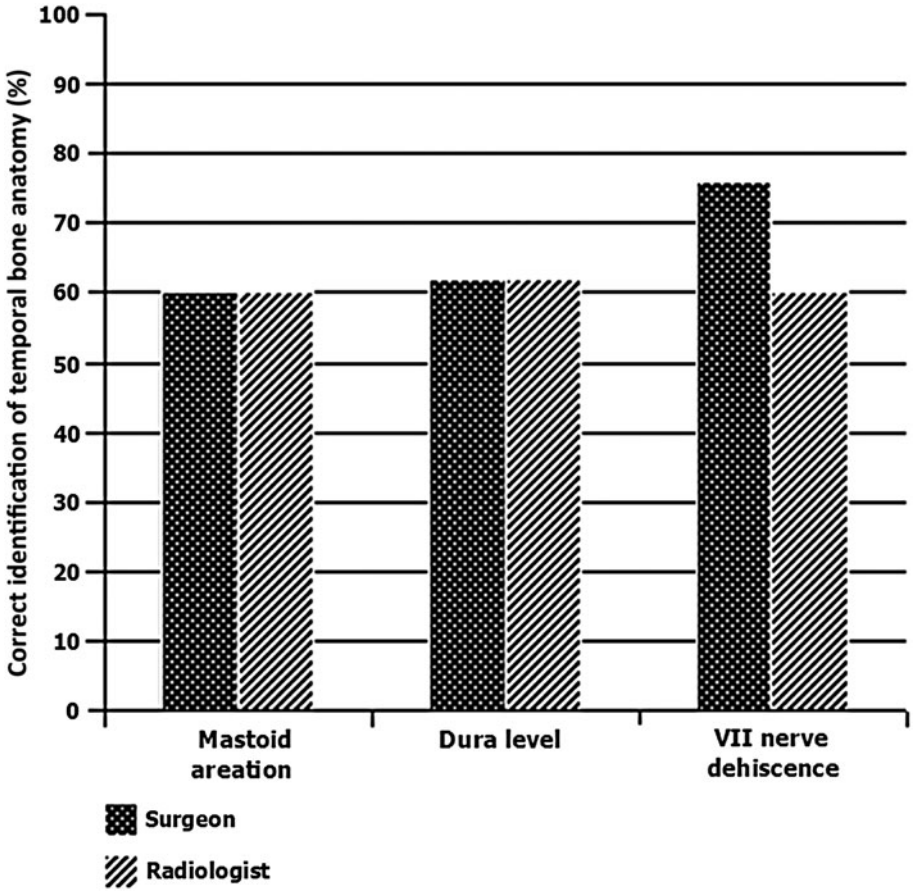

FIG. 1
Graph showing the percentage accuracy of computed tomography interpretations of temporal bone anatomy by the two reporters.

reporters were blinded to the original CT report and to intra-operative findings. Reported outcomes were anatomical variation (level of dura, mastoid aeration, facial nerve exposure), pathology extent (presence of cholesteatoma in the middle ear and/or attic and/or mastoid) and disease sequelae (erosion of ossicles and/or lateral canal and/or tegmen). Surgical findings were obtained from the international otology database and hospital electronic archives. Findings reported by the radiologist and the surgeon were compared with the operative findings. Cases with incomplete pre-operative findings were excluded. Minitab 16 (Minitab, State College, Pennsylvania, USA) was used for statistical analysis of the data. Positive and negative predictive values and accuracy were analysed and compared between reporters.

Results

After excluding 6 patients because of incomplete operative findings, CT scans of 42 patients were independently reviewed. The average time between CT imaging and surgery was four months. In reporting the temporal bone (Figures 1–3), the percentage correct interpretations of operative and pathological findings was comparable between the two reporters, albeit with minor differences: the surgeon's performance was better regarding VII nerve dehiscence (76 *vs* 60 per cent; Figure 1), with higher positive (71 *vs* 17 per cent) and negative (77 *vs* 67 per cent) predictive values (Table I). Both interpreters were better at detecting lateral canal dehiscence (Figure III).

However, the radiologist had a slightly better prediction of middle-ear disease. The radiologists had a higher accuracy and higher positive and negative predictive values for detecting cholesteatoma in the middle ear (57 *vs* 50 per cent, 56 *vs* 48 per cent and 58 *vs* 55 per cent, respectively), attic (76 *vs* 76 per cent, 90 *vs* 80 per cent and 42 *vs* 0 per cent, respectively) and mastoid (67 *vs* 62 per cent, 84 *vs* 72 per cent and 52 *vs* 47 per cent, respectively; Table I).

Overall, the there was no significant difference between the interpretations of temporal bone CT scans of the radiologist and otologist. However, the radiologist was significantly better at predicting lateral semicircular canal erosion, whereas the otologist was better at predicting facial canal erosion and tympanic membrane retraction. (Table I)

Discussion

This unique study evaluates the ability of an operating surgeon to report his own pre-operative CT images and compares his interpretations to those of the radiologist.

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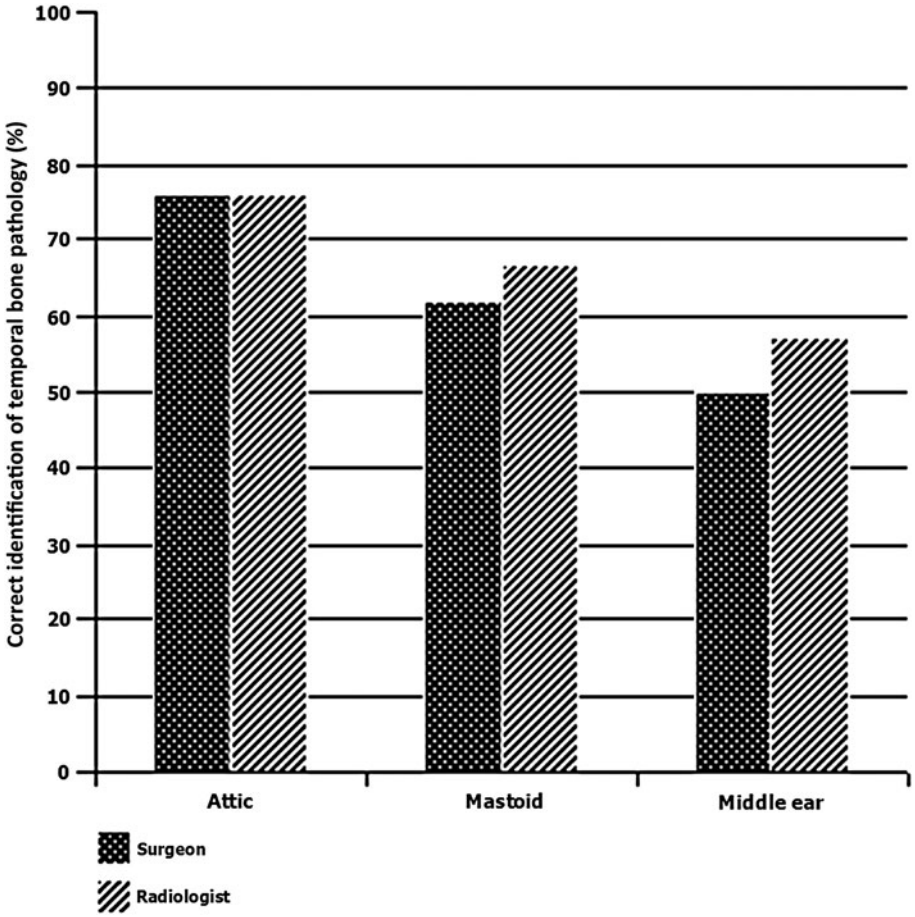

FIG. 2
Graph showing the percentage accuracy of computed tomography interpretations of pathology affecting different parts of the temporal bone by the two reporters.

Results were comparable between the two reporters, although some differences were found. These were welcomed by both reporters as providing a constructive learning experience. The methods were robust because all patients were operated on by the same surgeon and all images were evaluated by the same reporters. Use of the international otology database provided reliable information about intra-operative findings, and the use of a structured proforma added further credibility to our results. Blinding was regarded as unbiased owing to the time lag between the original reporting and/or surgery and this study.

Temporal bone CT has not gained wide acceptance as an essential aid to planning surgery for cholesteatoma, and many otologists reserve this procedure for selected patients that have complications of chronic suppurative otitis media, suspected congenital abnormalities or loss of landmarks owing to previous surgery.[2] Some authors, however, recommend routine scanning prior to all mastoid surgery because the disease process may not be apparent in clinical findings alone.[3]

There is general consensus in the literature that mastoid CT cannot be relied upon to distinguish cholesteatoma from mucosal disease.[4–7] Identifying the disease before surgery remains a topical issue because a higher complication risk is associated with cholesteatoma.[4] Some authors have even recommended the use of magnetic resonance imaging to distinguish the two conditions.[12,13] A higher accuracy of disease prediction in the middle ear, attic and mastoid by radiologists was noted in this study. This is because they are more proactive in considering bone density and erosion when making a diagnosis. In contrast, surgeons tend to concentrate more on anatomical features such as facial canal erosion and tympanic membrane retraction because these can have detrimental effects on surgical outcome.

Computed tomography was previously found to be helpful in determining middle-ear and mastoid cell anatomy.[1] This is an extremely important technique for surgeons to determine the best approach and avoid complications. One study showed that the mastoid air cell complex and sigmoid sinus are easier areas to assess radiologically compared with specific structures in the middle ear such as the oval window and the round window niche.[8] This suggests that the ability to identify different structures in the temporal bone varies according to their size, location and complexity.

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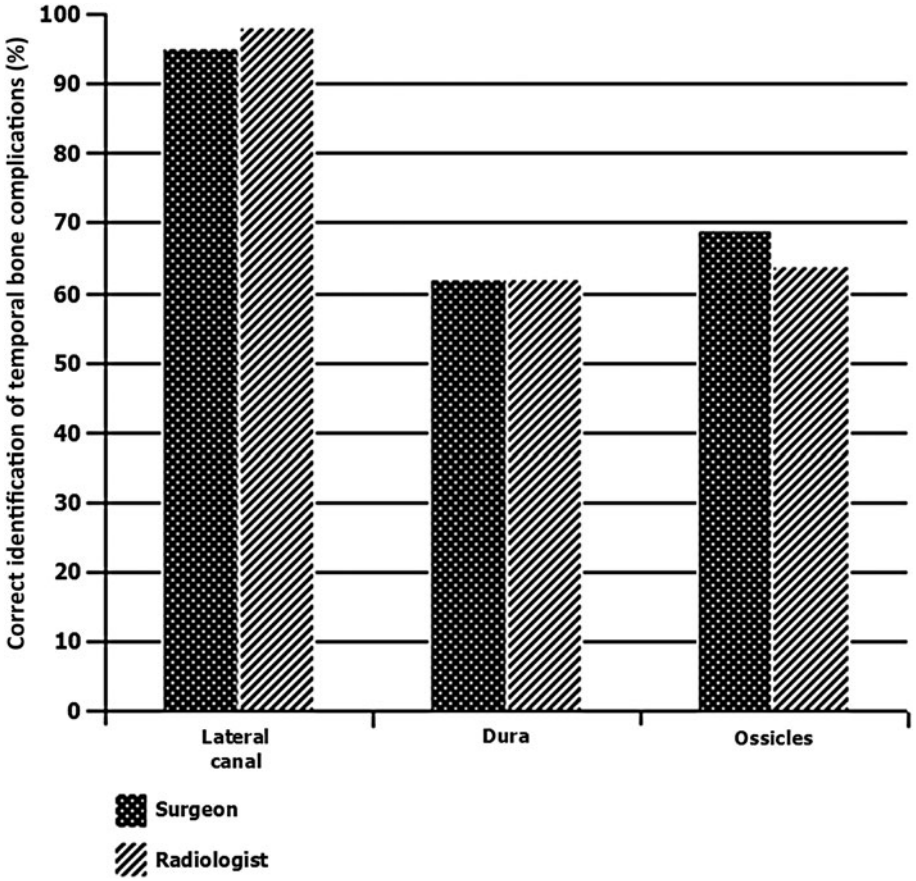

FIG. 3

Graph showing the percentage accuracy of computed tomography interpretations of complications affecting different parts of temporal bone by the two reporters.

Chronic otitis media usually erodes the long process of the incus, which is not normally seen on CT. The level of correct identification of this complication was moderate for both reporters. The negative predictive value for detecting ossicle erosion is reported to be no more than 27.8 per cent, which is very close to our findings (22 per cent for the radiologist and 21 per cent for the surgeon).[8] This means that visualisation of the incudomalleolar complex does not guarantee that this structure has not been eroded. O'Reilly *et al.* predicted an intact ossicular chain in only 50 per cent of cases, but our figures were better (69 per cent for the surgeon and 64 per cent for the radiologist).[11] Cholesteatoma can also erode the lateral semicircular canal; if the surgeon had prior knowledge of this, he would probably be more careful during dissection of

TABLE I
PERFORMANCE OF A SURGEON AND A RADIOLOGIST IN TEMPORAL BONE CT INTERPRETATIONS

Pathology, complication	Radiologist					Surgeons					*p* value
	Accuracy (%)	PPV (%)	NPV (%)	Sens (%)	Spec (%)	Accuracy (%)	PPV (%)	NPV (%)	Sens (%)	Spec (%)	
Mastoid aeration	60	85	13	64	33	60	91	21	58	67	0.183
TM retraction	50	63	21	53	29	67	71	50	86	29	0.000
Dura level	62	61	57	74	42	62	65	58	65	58	0.022
Middle-ear cholesteatoma	57	56	58	50	64	50	48	55	75	27	0.222
Attic cholesteatoma	76	90	42	79	62	76	80	0	94	0	0.949
Mastoid cholesteatoma	67	84	52	59	80	62	72	47	67	53	0.663
Ossicular erosion	64	96	22	62	80	69	93	21	70	60	0.092
Facial canal erosion	60	17	67	8	83	76	71	77	38	93	0.003
LSSC erosion	98	100	98	67	100	95	100	95	33	100	0.000
Tegmen erosion	93	75	95	60	97	98	83	100	100	97	0.070

CT = computed tomography; PPV = positive predictive value; NPV = negative predictive value; Sens = sensitivity; Spec = specificity; TM = tympanic membrane; LSSC = lateral semicircular canal

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diseased tissue to avoid creating a dead ear. O'Reilly *et al*. detected six out of eight cases and had a false positive rate of 3.5 per cent.[11] Jackler *et al*. had an even higher false positive rate and warned that mastoid CT gave an erroneous impression of lateral semicircular canal erosion.[14] In our series, neither the surgeon nor the radiologist had any false positives; both had 100 per cent positive predictive values.

- **Pre-operative temporal bone imaging can predict intra-operative findings of chronic ear disease**
- **Mastoid computed tomography can accurately predict tegmen and lateral semicircular canal erosion**
- **It is ineffective in identifying ossicular chain continuity and facial canal dehiscence**
- **It can poorly differentiate cholesteatoma from mucosal disease in the middle ear**
- **There was no significant difference between computed tomography scan interpretation between specialists**

Limitations

The limitation of our study relates to the distribution of actual pathologies, as found in any similar mastoid series.[8] Lateral canal and tegmen pathology are rare, thus reducing the sensitivity because of this calculation is based on the few abnormal cases with an eroded canal or tegmen. In contrast, most of our patient had low cellular (sclerotic) mastoids and, for the reason given above, the specificity values are lower because they are based on the few normal cases with cellular mastoid. In addition, a larger sample is required to draw more robust conclusions.

Conclusion

This study shows that pre-operative CT scanning of the temporal bone in chronic otitis media is useful for predicting attic pathology and lateral canal erosion but is less effective for delineating ossicular chain continuity, detecting facial canal dehiscence and distinguishing cholesteatoma from mucosal disease in the middle ear. The radiologist was significantly better at predicting lateral semicircular canal erosion, whereas the otologist did well in predicting facial canal erosion and tympanic membrane retraction. Better coordination between clinicians and use of a structured reporting tool can enhance the quality and usefulness of the CT scan report.

References

1 Walshe P, McConn Walsh R, Brennan P, Walsh M. The role of computerized tomography in the preoperative assessment of chronic suppurative otitis media. *Clin Otolaryngol* 2002;**27**:95–7
2 Yates PD, Flood LM, Banerjee A, Clifford K. CT scanning of middle ear cholesteatoma: what does the surgeon want to know? *Br J Radiol* 2002;**75**:847–52
3 Blevins NH, Carter BL. Routine preoperative imaging in chronic ear surgery. *Am J Otol* 1998;**19**:527–38
4 O'Donoghue GM, Bates GJ, Anslow P, Rothera MP. The predictive value of high resolution computerized tomography in chronic suppurative ear disease. *Clin Otolaryngol Allied Sci* 1987;**12**:89–96
5 Alzoubi FQ, Odat HA, Al-Balas HA. Saeed SR. The role of preoperative CT scan in patients with chronic otitis media. *Eur Arch Otorhinolaryngol* 2009;**266**:807–9
6 Wang LE, Gu YF, Wu YQ, Zhuang QX, Lin Y, Yin SK. Significance of CT in diagnosis of chronic suppurative otitis media [in Chinese]. *Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi* 2007;**42**:494–8
7 Garber LZ, Dort JC. Cholesteatoma: diagnosis and staging by CT scan. *J Otolaryngol* 1994;**23**:121–4
8 Vlastarakos PV, Kiprouli C, Pappas S, Xenelis J, Maragoudakis P, Troupis G *et al*. CT scan versus surgery: how reliable is the preoperative radiological assessment in patients with chronic otitis media? *Eur Arch Otorhinolaryngol* 2012;**269**:81–6
9 Tatlipinar A, Tuncel A, Öğredik EAGökçeer T, Uslu C. The role of computed tomography scanning in chronic otitis media. *Eur Arch Otorhinolaryngol* 2012;**269**:33–8
10 Mafee MF, Levin BC, Applebaum EL, Campos M, James CF. Cholesteatoma of the middle ear and mastoid. A comparison of CT scan and operative findings. *Otolaryngol Clin North Am* 1988;**21**:265–93
11 O'Reilly BJ, Chevretton EB, Wylie I, Thakkar C, Butler P, Sathanathan N *et al*. The value of CT scanning in chronic suppurative otitis media. *J Laryngol Otol* 1991;**105**:990–4
12 Teschner M, Hinz K, Stöver T, Lenarz T, Becker H. Diffusion-weighted MRI in the diagnosis of cholesteatomas. *ORL J Otorhinolaryngol Relat Spec* 2009;**71**:99–104
13 Vercruysse JP, De Foer B, Somers TCasselman J, Offeciers E. Magnetic resonance imaging of cholesteatoma: an update. *B-ENT* 2009;**5**:233–40
14 Jackler RK, Dillon WP, Schindler RA. Computed tomography in suppurative ear disease: a correlation of surgical and radiographic findings. *Laryngoscope* 1984;**94**:746–52

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Appendix I

The value of pre-operative mastoid computed tomography

1. Laterality

Right ear ☐ Left ear ☐

Please affix patient label

2. Anatomy

	Normal	Abnormal
Mastoid bone	Cellular ☐	Sclerotic ☐
Tympanic membrane	Normal ☐	Retracted ☐
Dura	High ☐	Low ☐

3. Pathology

	Cholesteatoma	Mucosal disease	Normal	Cannot decide
Mesotympanum	☐	☐	☐	☐
Attic	☐	☐	☐	☐
Mastoid	☐	☐	☐	☐

4. Complications

	Intact	Eroded	Removed (revision)
Ossicles	☐	☐	☐
Facial nerve	☐	☐	N/A
Lateral canal	☐	☐	N/A
Dura (tegmen)	☐	☐	N/A

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