TMC: a new staging system for tympanomastoid cholesteatoma
Aziz Belal, Mahmoud Reda, Ahmed Mehanna and Yousef Belal

Alexandria Ear Hospital, Alexandria, Egypt
Correspondence to Mahmoud Reda, Alexandria Ear Hospital, Alexandria, Egypt
Tel: +01223363987; e-mail: mahmoudreda99@yahoo.com

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Objective
To present a new staging system for tympanomastoid cholesteatoma that is based on
the primary site of pathology in the middle ear (T), its spread to the mastoid (M), and to
the surrounding structures, either cranial, intracranial, or extracranial, and presence of
complications (C).

Setting
Tertiary Care Center (ENT Department, Faculty of Medicine, University of Alexandria,
Egypt).

Study design
Clinical Prospective Study.

Methods
The TMC staging system is based on the correlation of preoperative otoscopy findings
with computed tomography examination of the temporal bone. Preoperative findings
have also been correlated with intraoperative findings.

Patients
We included 120 patients with tympanomastoid cholesteatoma diagnosed
preoperatively.

Results
In 87% of the patients, preoperative and intraoperative staging were well correlated.

Conclusion
The TMC staging system of cholesteatoma paves the way to a logical roadmap for
functional surgery of the middle ear and mastoid; in addition, it makes the comparison
of clinical studies about cholesteatoma meaningful.

Keywords:
atricotomy, cholesteatoma, mastoid, mastoidectomy, tympanic cavity

Introduction
Surgical strategy of tympanomastoid cholesteatoma may be based on factors related to the patient, surgeon, or
disease. Patient factors include general factors, such as age, general medical status, and occupation and local
factors, such as status of hearing, only one hearing ear, bilateral cholesteatoma, mastoid pneumatization, and
eustachian tube function. Surgeon factors include preference and training of the surgeon at a particular time.
Factors related to the disease include the anatomical site of origin, paths of spread inside and outside the temporal
bone, histological characteristics and biological behavior of cholesteatoma. Pathology seems to be the most logical
way to outline a surgical strategy for cholesteatoma [1–3].

Why staging cholesteatoma?
Reviewing the techniques used to manage middle ear cholesteatoma showed that priority was given to the
mastoid rather than the middle ear [3–6]. However, histopathological and clinico-operative studies have shown
that the involvement of middle ear is much higher than the mastoid in primary and revision cholesteatoma cases [7–11].
Thus, we have to emphasize the concept that is based on tailoring the surgical technique according to the site of
pathology and its extensions. Comparison of clinical and operative studies about tympanomastoid cholesteatoma
always had the problem of finding a ‘standard’ to make a meaningful comparison. Terms of small, big, and huge
cholesteatomas made comparisons between the different studies like comparing apples to oranges.

A standard staging system will definitely solve this problem.

Attempts to stage tympanomastoid cholesteatoma
The classical etiological classification [7] of cholesteatoma into congenital, primary acquired, and secondary
acquired cholesteatoma is an etiopathological classification and describes well the site of origin of choles-
steatoma, its paths of spread, and its histological behavior.

Lau and Tos [8] otoscopically classified cholesteatoma into the following types: attic type in the pars flaccida of the
eardrum; sinus cholesteatoma starting as a postero-superior retraction or perforation of the pars tensa and
extending to the tympanic sinus, posterior tympanum, and beyond; and tensa cholesteatoma presenting as
retraction and adhesion of the entire pars tensa involving the tympanic orifice of the Eustachian tube (it may also
extend further into the attic).
Tos and Lau [12] latter modified their classification into: attic, pars tensa I (marginal disease), and pars tensa II (central disease) cholesteatomas. Meyerhoff and Truelson [13] classified cholesteatoma into primary acquired, secondary acquired, tertiary acquired, and congenital cholesteatomas.

Saleh and Mills [14] introduced the Site-Ossicles-Complications classification System. It can be summarized as follows:

S1: if the cholesteatoma is restricted to the site where it had started.
S2: when the disease extends to another site.
S3: if it affects three sites.
S4: if it affects four sites.
S5: cases in which the primary site is affected plus four or more sites are also involved.

Authors distinguished seven sites used in this classification: attic, antrum, middle ear, mastoid, auditory tube, labyrinth, and middle fossa.

O0: if the ossicle chain is intact.
O1: if incus is eroded but without chain discontinuity.
O2: if incus and stapes suprastructures are eroded.
O3: if the malleus head and incus are absent and stapes superstructure is eroded.
C0: when there is no complication.
C1: if there is one complication.
C2: if there are two or more complications.

Regarding complications, the authors considered lateral semicircular canal fistula, facial palsy, total sensorineural auditory loss, sinus thrombosis, and intracranial invasion.

We thought that the latter staging system was very useful and well designed. However, it did not use and correlate to the computed tomography (CT) scanning, which has an important rule in studying the site of tympanomastoid cholesteatoma, in the staging system. It staged ears according to the status of ossicles, which is not a reliable factor because the final status of the ossicular chain cannot be assessed except after the disease has been completely eradicated. Furthermore, the previous staging system did not categorize complications into cranial and intracranial, which we think is an important point in staging.

**New staging system for tympanomastoid cholesteatoma**

After reviewing the previous staging system, and depending on our clinico-operative observations and experiences, we designed a new staging system for tympanomastoid cholesteatoma from stage 1 to stage 5 depending on the site of disease in the tympanic cavity (T), the mastoid cavity (M), and the presence of any complication (C).

Staging of any case is made according to the official clinical (otoscopic/microscopic/endoscopic) examination, the radiological study (axial, coronal, and sagittal reconstruction views of high-definition CT Petrous bone), and the clinicoradiological correlation. (Tables 1 and 2, Fig. 1).

**Case reports**

**Case 1**
A 40-year-old patient presented with recurrent discharging from the right ear.

**Otoscopy:** attic cholesteatoma and small polyp on one side of the head of malleus and normal mesotympanum (T1a).

**CT scan:** it showed attic cholesteatoma with the involvement of the mastoid cavity only in the antrum (M1).

There was no clinical or radiological manifestation of complications (C0).

<table>
<thead>
<tr>
<th>Table 1 TMC Staging system of tympanomastoid cholesteatoma</th>
</tr>
</thead>
<tbody>
<tr>
<td>(T) Tympanic cavity involvement:</td>
</tr>
<tr>
<td>T0: no tympanic cavity involvement</td>
</tr>
<tr>
<td>Trp: retraction pocket (precholesteatoma)</td>
</tr>
<tr>
<td>T1: cholesteatoma involving one side of one region</td>
</tr>
<tr>
<td>T1a: one side of epitympanum</td>
</tr>
<tr>
<td>T1b: one side of mesotympanum</td>
</tr>
<tr>
<td>T2: cholesteatoma involving both sides of one region</td>
</tr>
<tr>
<td>T1a: both sides of epitympanum</td>
</tr>
<tr>
<td>T1b: both sides of mesotympanum</td>
</tr>
<tr>
<td>T3: cholesteatoma extending from one region of the middle ear to another (vertical spread)</td>
</tr>
<tr>
<td>T4: holotympanic cholesteatoma filling the whole middle ear</td>
</tr>
<tr>
<td>Regions (epitympanum, mesotympanum, and hypotympanum)</td>
</tr>
<tr>
<td>Sides (anterior or posterior in relation to a line along handle of malleus)</td>
</tr>
<tr>
<td>(M) Mastoid cavity involvement:</td>
</tr>
<tr>
<td>M0: no mastoid cavity involvement</td>
</tr>
<tr>
<td>M1: cholesteatoma extending to the mastoid antrum only</td>
</tr>
<tr>
<td>M2: cholesteatoma extending to mastoid cavity</td>
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<tr>
<td>(C) Presence of complications:</td>
</tr>
<tr>
<td>C0: uncomplicated cholesteatoma</td>
</tr>
<tr>
<td>C1: cranial or extracranial complication</td>
</tr>
<tr>
<td>C2: intracranial complications</td>
</tr>
<tr>
<td>Stages</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Trp-1 M0 C0</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>T2 M0 C0</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>T3 M0 C0</td>
</tr>
<tr>
<td>Trp-3 M1 C0</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>T4 M0 C0</td>
</tr>
<tr>
<td>Any T M2 C0</td>
</tr>
<tr>
<td>Any T Any M C1</td>
</tr>
</tbody>
</table>

C, complication; M, mastoid; rp, retraction pocket; T, tympanic.
Staging: T1M1C0 = stage 3, intraoperative findings were corresponding to TMC staging (Fig. 2).

Case 2
A 24-year-old male patient presented with right ear hearing loss and occasional ear discharge.

*Otoscopy:* it showed a white pearly mass behind an intact tympanic membrane (T3).

*CT scan:* it showed a soft tissue mass in the tympanic cavity, with well-aerated mastoid (M0). The mass was eroding the basal turn of the cochlea (C1).

Staging: T3M0C1 = stage 4, intraoperative findings were corresponding to TMC staging (Fig. 3).

Case 3
A 35-year-old male patient presented with persistent foul-smelling intermittent discharge from the right ear.

*Otoscopy:* it showed cholesteatoma involving the whole tympanic cavity (T4).

*CT scan:* it showed cholesteatoma filling the whole mastoid cavity (M2).

There was no clinical or radiological manifestation of complications (C0).

Staging: T4M2C0 = stage 4, intraoperative findings were corresponding to TMC staging (Fig. 4).

**Correlation of preoperative and intraoperative findings**
A total of 120 cases of tympanomastoid cholesteatoma examined and operated at the Alexandria Ear Hospital, Egypt in the period between 2005 and 2010 were included in this study. Cases were examined preoperatively (otoscopy, microscopy, and endoscopy), were CT scanned (coronal and sagittal views), and then were preoperatively staged according to the TMC staging system. Cases were operated upon and then staged again according to the intraoperative findings. Staging correlated well in 87% of cases. Preoperative staging underestimated the size of cholesteatoma in 11% of the cases and overestimated it in 1% of cases. Table 2 summarizes the preoperative and intraoperative findings in these cases. MRI imaging of the temporal bone may help in better preoperative estimation of the size of cholesteatoma in future.

**Conclusion**
Although different staging systems for tympanomastoid cholesteatoma were described, they did not use the

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**Table 2 Comparison of preoperative and intraoperative findings**

<table>
<thead>
<tr>
<th>Stage</th>
<th>No. of cases</th>
<th>Good correlation</th>
<th>Underestimated cases</th>
<th>Overestimated Cases</th>
<th>Correlation (%)</th>
<th>Average correlation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>5</td>
<td>5</td>
<td>–</td>
<td>–</td>
<td>100</td>
<td>87.3</td>
</tr>
<tr>
<td>T2</td>
<td>42</td>
<td>40</td>
<td>2</td>
<td>–</td>
<td>–</td>
<td>95</td>
</tr>
<tr>
<td>T3</td>
<td>58</td>
<td>40</td>
<td>16</td>
<td>2</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>T4</td>
<td>15</td>
<td>13</td>
<td>1</td>
<td>1</td>
<td>86.5</td>
<td></td>
</tr>
<tr>
<td>M0</td>
<td>37</td>
<td>18</td>
<td>9</td>
<td>–</td>
<td>86.6</td>
<td></td>
</tr>
<tr>
<td>M1</td>
<td>39</td>
<td>20</td>
<td>9</td>
<td>1</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>M2</td>
<td>54</td>
<td>50</td>
<td>–</td>
<td>4</td>
<td>92.5</td>
<td></td>
</tr>
<tr>
<td>C0</td>
<td>115</td>
<td>104</td>
<td>11</td>
<td>–</td>
<td>90</td>
<td>96.6</td>
</tr>
<tr>
<td>C1</td>
<td>3</td>
<td>3</td>
<td>–</td>
<td>–</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>2</td>
<td>2</td>
<td>–</td>
<td>–</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Total no. of cases</td>
<td>120</td>
<td>87%</td>
<td>11%</td>
<td>1%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1**

Staging system of tympanomastoid cholesteatoma.
advances in CT scanning, they overestimate the importance of preoperative status of ossicles, and they did not categorize complications into cranial and intracranial. Our TMC staging system is a clinicoradiological system that depends on the correlation between preoperative and intraoperative findings. TMC staging can be used to plan a roadmap of functional surgery in cases of tympanomastoid cholesteatoma. Furthermore, it simplifies the terminology

Figure 2

Otoscopic and computed tomography findings of case 1.

Figure 3

Otoscopic and computed tomography findings of case 2.

Figure 4

Otoscopic and computed tomography findings of case 3.
used to describe a case of tympanomastoid cholesteatoma. Thus, it facilitates a reliable type-specific comparison of published data reporting the results of tympanomastoid surgery. With the advances in the radiodiagnosis and histopathological technology, more tools of assessment of tympanomastoid cholesteatoma can be applied to design a more beneficial staging system in the future.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

References

12 Tos M, Lau T. Late results of surgery in different cholesteatoma types. ORL 1989; 51:33–49.