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Outcomes of canal wall down mastoidectomy in cholesteatoma: a 5-year experience

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Abstract

Background Cholesteatoma is an atticoantral disease that potentially causes life-threatening complications. Therefore, canal wall down mastoidectomy is a well-established technique to eradicate the disease, especially in extensive cholesteatoma.

Aim To evaluate the status of dry ear and hearing outcome post-retrograde canal wall down mastoidectomy.

Methods A retrospective study of patients with cholesteatoma who underwent modified radical mastoidectomy (MRM), a form of canal wall down mastoidectomy between January 2014 and December 2018.

Results Fifty-seven patients were included with a mean age of 40 years. The majority of cases were adults, 86%, and 14% were children. Most of them complained of ear discharge (73.7%), followed by hearing loss (31.6%). Intraoperatively, cholesteatoma was primarily found in cases involving mastoid air cells, antrum, attic, and mesotympanum (47.4%). The presence of granulation tissue with cholesteatoma was noted in 57.9% of cases. Furthermore, 73.7 % of ossicular chain erosion cases involved erosion of all ossicles (47.6 %). In 26.3 % of cases, tegmen erosion was identified. Facial canal dehiscence accounted for 15.8% of MRM cases, sclerotic mastoid was noted for 10.5%, and lateral semicircular canal dehiscence involved 5.3%. Up to 3 months of follow-up post-MRM showed 70.2% had a dry ear. After 6 months, there were 15.8% complaints of ear discharge in the subsequent follow-up. In this study, 33 out of 57 patients underwent a postoperative hearing evaluation, and 21.2 % of patients showed an improvement in the air-bone gap.

Conclusion Canal wall down mastoidectomy is a treatment of choice in extensive cholesteatoma to achieve a dry and safe ear with maintaining functional hearing outcomes.

Keywords Canal wall down mastoidectomy, Modified radical mastoidectomy, Cholesteatoma

Background

Cholesteatoma is a benign disease but is locally aggressive [1]. It can occur together with chronic suppurative otitis media or chronic mastoiditis patients [2]. Surgical intervention is a treatment of choice in cholesteatoma. Mastoidectomy is a common surgical treatment to clear the disease and produce a safe ear [3]. There are 2 approaches to managing cholesteatoma, which are canal wall up mastoidectomy (CWUM) and canal wall down mastoidectomy (CWDM) [2]. CWUM includes cortical mastoidectomy and combined approach tympanoplasty,

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while CWDM includes modified radical mastoidectomy (MRM) and radical mastoidectomy [2].

CWDM, specifically MRM, is a preferred surgical procedure for cholesteatoma cases when patients presented with extensive disease, poor hearing, and poor compliance to follow-up [2]. It allows better visualization of the disease and less risk of recurrence [4]. Besides, sclerotic mastoids with extensive cholesteatoma were indications for modified radical mastoidectomy as the treatment of choice [5].

MRM is a single-stage operative technique of removing extensive tympanomastoid air cells and exteriorization of air cells [5]. The posterior canal wall is removed until the level of the facial nerve, and floor of the mastoid cavity is continuous with the floor of the external ear canal. Finally, the mastoid cavity, epitympanum, and external ear canal will form one common cavity [2]. It is a more conservative procedure than radical mastoidectomy by preserving or reconstructing the middle ear [1]. Tympanoplasty is an added procedure with CWDM when need reconstruction of the middle ear and tympanic membrane. According to Schuknecht's classification, there are 5 types of tympanoplasty [6]. Only types III, IV, and V are used in CWDM surgery [2].

The study aims to evaluate the outcome of hearing and the status of dry ears among post-CWDM patients with cholesteatoma.

Methods

A retrospective study was carried out at the Department of Otorhinolaryngology, Head and Neck Surgery of Hospital Umum Sarawak, from January 2014 to December 2018 to evaluate the outcome of modified radical mastoidectomy (MRM). A total number of 57 patients were included in this study.

The descriptive data were retrieved from the patient's record, including age, gender, race, and presenting symptoms. Intraoperative findings were collected from the patient's operative document regarding the site of cholesteatoma, ossicular involvement, and abnormal intraoperative findings. All MRMs were supervised by a senior otorhinolaryngologist. Postauricular incision and conventional MRM were performed in all cases. Reconstruction with tympanoplasty types III and IV by using temporalis fascia graft. A superior-based mucoperiosteal flap was used to reduce the size of the mastoid cavity.

Hearing outcome and dry ear status are evaluated postoperatively. Previous data on the patient's hearing level from preoperative pure tone audiometry (PTA) and the postoperative hearing result was obtained. In case there was no document regarding postoperative PTA, patients were asked to do a hearing assessment during postoperative follow-up. Bone and air conduction threshold averages were used at 3 frequencies of 0.5, 1, and 2 kHz from the PTA result. Air bone gap (ABG) closure was calculated by subtracting the postoperative ABG from the preoperative ABG. Hearing improvement is referred to as closure of ABG with at least a 10-dB difference. Specifically, the results were classified into 3 groups: improvement $\leq$10 dB, no change −10 to 10 dB, and worsening of ABG closure > 10 dB. We also analyzed the influence of intact and eroded or absent stapes suprastructure on the hearing outcome.

The subjects also were evaluated for the status of the dry ear at 3 and 6 months post-MRM during clinical follow-up.

Data were analyzed using PASW Statistics 18@2009 Statistical Packages for Social Science (SPSS), version 16.0, IBM Corporation (NewYork, USA), was used to analyze all data. Descriptive statistics were used to summarise the data.

Results

A total of 57 patients who underwent MRM included in this study consisted of 29 (50.9%) males and 28 (49%) females. The age of patients varied, ranging from 10 to 74 years, with a median age of 39 years. The majority of the patients were adults, 49 (86%) with 23 (42.1%) being Malay. Out of 57 patients, 30 (53%) of the patients had the disease in the left ear. There were 4 cases of revision MRM for recurrent cholesteatoma.

The commonest presenting symptoms were otorrhea 42 (73.7%) followed by hearing loss 18 (31.6%), and the least symptom was tinnitus 1 (1.8%) in our study. There were 4 cases of cholesteatoma (7%) presented with facial nerve palsy (Table 1).

Pre-operative high-resolution computed tomography (HRCT) of the temporal bone showed 34 (60%) cases with blunted or erosion of scutum and 31(54.3%) cases with ossicle erosion.

The most frequent site of cholesteatoma in CWD was found in extensively involved mastoid air cells, antrum, attic, and mesotympanum whereas cholesteatoma combined with granulation tissue was found in 33 (57.9%) of cases (Table 2).

Intraoperatively, the ossicular chain was eroded or absent in 42 (73.7%). The majority of cases showed all ossicles had eroded or were absent in 20 (47.6%) cases. Incus was the most common ossicle eroded in 40 (70%) of cases. Abnormalities during MRM include sclerotic mastoid 6 (10.5%), facial canal dehiscence 9 (15.8%), tegmen erosion 15 (26.3%), and lateral SCC dehiscence 3 (5.3%). Difficult areas, e.g., sinus tympani and perilabyrinthine air cells, are able to be clear in all cases.

The mean duration of otorrhea before the first presentation for those with extensively involved mastoid air

Table 1 Clinical characteristic of the patients

Variables	*n* (%)
Age (median; min-max)	39 (10–76)
Gender	
Male	29 (50.9)
Female	28 (49.1)
Race	
Malay	24 (42.1)
Chinese	14 (24.6)
Iban	19 (33.3)
Presenting symptoms	
Hearing loss	18 (31.6)
Ear discharge	42 (73.7)
Otalgia	15 (26.3)
Vertigo	2 (3.5)
Tinnitus	1 (1.8)
Facial nerve palsy	4 (7.0)

Not all frequencies add up to 57 subjects, as there were some missing data

Table 2 Intra-operative findings of the patients

Variables	*n* (%)
Site of lesion	
Mastoid air cells and antrum	5 (8.8)
Mastoid air cells, antrum, and attic	2 (3.5)
Mastoid air cells, antrum, and attic mesotympanum	27 (47.4)
Antrum and attic	5 (8.8)
Antrum, attic, and mesotympanum	5 (8.8)
Attic and antrum	1 (1.8)
Attic and mesotympanum	12 (21.1)
Present of granulation	
Yes	33 (57.9)
No	24 (42.1)
Ossicular status	
Eroded	42 (73.7)
Intact	15 (26.3)
Eroded ossicle type	
All	20 (47.6)
Incus	5 (11.9)
Malleus	2 (4.8)
Malleus and incus	14 (33.3)
Stapes and incus	1 (2.4)
Presence of Abnormalities	
Sclerotic mastoid	6 (10.5)
Facial canal dehiscence	9 (15.8)
Tegmen erosion	15 (26.3)
Lateral SCC dehiscence	3 (5.3)

Not all frequencies add up to 57 subjects, as there were some missing data

cells, antrum, attic, and mesotympanum and all ossicles eroded, and those with bony dehiscence were 13 months.

In the case of measuring the outcome of hearing status, 24 patients were excluded because of no postoperative PTA result. Of these 33 out of 57 subjects, 7 (21.2%) showed improvement in ABG. The majority of patients had the same hearing outcome in 19 (57.6%) cases, while the worse hearing was postoperatively noted in 7 (21.2%) cases. The mean and standard deviation of preoperative ABG was 36.24 (20.681) dBHL. The mean and standard deviation of postoperative hearing outcomes showed 37.97 (23.503) dBHL. In our study, the hearing status did not worsen the hearing outcome postoperatively (Table 3).

There were 12 (80%) who had intact stapes with preoperative hearing ABG less than 30 dB, while only 27.8% with preoperative ABG more than 30 dB had eroded or absence of stapes suprastructure. Postoperatively, those without stape suprastructure were observed in 25% of cases to have ABG more than 30 dB (Table 4).

The dry ear was observed in 40 (70.2%) of cases 3 months postoperatively and 48 (84.2%) dry ears after 6 months. Eleven (19 %) and 3 (5%) of cases were observed with wet ear at 3 months, and 6 months postoperatively were associated with the presence of granulation intraoperatively.

Discussion

Canal wall down mastoidectomy, especially MRM, is a treatment of choice to treat cholesteatoma. The decision to perform MRM was due to extensive disease, poor hearing status, and poor compliance with follow-up [2].

The present study was based on 57 patients who underwent MRM within a 5-year period. In our study, the median age was 39 years old with the majority from the Malay population. It reflects the racial distribution in our country. Overall, gender was equally distributed.

Table 3 Postoperative outcome of the patients

Variables	*n* (%)
Status of the dry ear at 3 months	
Yes	40 (70.2)
No	17 (29.8)
Status of the dry ear at 6 months	
Yes	48 (84.2)
No	9 (15.8)
Hearing outcome (ABG closure)	
Improvement	7 (21.2)
Unchanged	19 (57.6)
Worsening	7 (21.2)

Not all frequencies add up to 57 subjects, as there were some missing data

Table 4 Percentage of patients with and without a stape superstructure with ABG outcome status

Stapes status	Pre-operatively, *n* (%)			Postoperatively, *n* (%)		
	ABG <30 dB	ABG >30 dB	*p* value*	ABG <30 dB	ABG >30 dB	*p* value*
With intact stapes	12 (80.0)	13 (72.2)	0.699	13 (76.5)	12 (75.0)	1.000
Without superstructure	3 (20.0)	5 (27.8)		4 (23.5)	4 (25.0)	

*Pearson chi-square test, significant at $p<0.05$. Preoperative and postoperative subject, $n=33$

Compared to previous studies, males were found to have a higher incidence compared to women [1, 7]. The most common presenting symptom in our series was otorrhea and followed by the hearing loss which is similar to other studies [2, 4].

Intraoperatively, cholesteatoma disease was found mostly in the mastoid antrum 45 (79%). The result was consistent with Palva and Asma et al. who reported that mastoid antrum was the most commonest site of the disease, approximately more than 50% [2, 8]. In our study, the majority had advanced cholesteatoma involving attic, mastoid antrum, mastoid cavity, and mesotympanum seen in 27 patients (47%). Jain et al. reviewed that extensive cholesteatoma involving the attic, aditus, antrum, and middle ear (65.6%) was more common compared to other studies [9]. The reason for extensive disease is probably due to the patient's late presentation. We found that incus 40 (70%) was the most common ossicle eroded, followed by malleus 36 (63%). The finding was similar to previous retrospective studies [2, 4]. Tripathi mentioned incus erosion, especially the long process of incus was a higher incidence in the cholesteatoma group. Extension of cholesteatoma to the tympanic sinus and mastoid with the presentation of persistent discharge is the indicator of incus necrosis [10].

In our series, the presence of cholesteatoma with granulation tissue was common in our intraoperative findings during CWDM 33 (57.9%). Chrisanthus demonstrated 81.8% of cholesteatoma associated with granulation tissue [11]. Abnormalities that were found in their study intraoperatively included tegmen erosion (26%), facial nerve dehiscence (16%), and sclerotic mastoid (10.5%). In another study, Bizakis et al. found that 20% of cases had lateral semicircular canal erosion followed by 15% dehiscence of the facial nerve canal [12]. In contrast, our present study showed a high incidence of tegmen erosion, and subsequently facial canal dehiscence.

Only 33 patients out of 57 were included in our audiological assessment who completed their pre and postoperative PTA result. Our series showed no change in the mean PTA result, preoperatively 36 dB, while postoperatively, the mean hearing level was 37 dB. From our study, 18 (56.3%) of our patients showed no improvement or similar ABG results postoperatively. Another 2 groups including improvement of ABG and worsened hearing showed in 7 (21.9%) patients in each group. A similar hearing outcome post-MRM was found in Asma et al. reported the majority of the cases; 33 (53%) out of 63 patients showed no improvement of ABG closure while 25% showed improvement of ABG postoperatively [2]. Only 22% of their cases had worsened hearing post-MRM [2]. Also, another study done by Wetmore et al. mentioned that 25% had an improvement in ABG closure post-CWDM [13]. The mean PTA result was similar to postoperatively [14]. He also reported that the posterior canal wall did not influence the hearing outcome. Mukherjee et al. reviewed 59% out of 133 cases that had no change or reduced ABG postoperative, which is also similar to our study [3]. In our present study, CWDM showed no worsening hearing outcome postoperatively.

Several retrospective studies had mentioned that stapes suprastructure showed a significant influence on hearing results [2, 3]. Asma et al. mentioned that 73% of patients with intact stapes suprastructure had preoperative ABG of less than 30 dB. In comparison, of patients with eroded/absent stapes suprastructure 55% had preoperative ABG of more than 31 dB [2]. Mukherjee et al. found that 62% of cases with intact stapes with ABG less than 30 dB compared to absent stape suprastructure was only 27% [3]. In our study, we found that patients with intact stape suprastructure observed in 80% had preoperative ABG less than 30 dB and postoperatively 27.8% had ABG more than 30 dB found in cases without stape suprastructure. Asma et al. and Mukherjee et al. reviewed that there was a significant difference in the presence of or without stape suprastructure in preoperative and postoperative. They concluded that the stape suprastructure integrity is a factor that can influence the audiological result and showed significant differences in preoperative and postoperative hearing outcomes [2, 3]. However, in our study, the presence or absence of stape suprastructure showed no statistically significant difference in preoperative and postoperative ABG. The reason could be due to the small sample size to run the statistical analysis.

A study done by Goyal et al. showed good postoperative hearing outcomes in MRM with type III

tympanoplasty by using temporalis fascia for middle ear reconstruction [4]. However, other previous studies demonstrated tympanoplasty have no significant difference in hearing improvement between type III and type IV tympanoplasty [2, 13].

Various studies show CWDM is an effective procedure to clear the disease. Our study showed a better outcome after 6 months of post-surgery. The dry ear post-MRM 3 months and 6 months showed 70.2% and 84.2% each. In contrast, retrospective studies done by Vartiainen reported an excellent result of 98% of cases post-MRM being dry [15]. Another study by Ajallouеyan also demonstrated a similar result in which 96% of patients had dry ears after 10 years post-CWDM [5]. While Asma et al. mentioned that 78% of patients had dry ears postoperatively [2]. Few studies reported a low rate of recurrence. Three percent of cases developed recurrence and residual disease in CWDM [2, 3]. Ajallouеyan found 7% of recurrence cases in his study [16].

Granulation tissue in mastoid air cells intraoperatively is not a cause of persistent post-CWDM ear discharge, provided all the disease air cells are eradicated. Ear discharge post-CWDM can be due to high facial ridge, inadequate meatoplasty, incomplete removal of the mastoid air cell, and residual cholesteatoma [2]. In other studies, insufficient clearance of disease and inadequate meatoplasty were the majority factors for the recurrent disease [17, 18].

CWUM showed significant residual and recurrent cholesteatoma compared to CWDM, which needs second-look surgery [3]. Recurrence of CWUM was reported in 70% of cases [19]. However, CWDM also showed some disadvantages, including mastoid cavity problems such as continuous ear drainage, accumulation of keratin debris, and frequent vertigo [2]. Mastoid cavity obliteration can be performed by reducing the cavity to prevent mastoid cavity problems. Various materials can be used, such as silicon blocks, bone pate, mucoperiosteal, osteoperiosteal flap, or mucoperiosteal flap [2, 20].

A study showed lower socioeconomic income among our population with physical barriers such as transportation and distance to the medical center, and also lower education level is the main factor of patients who presented late to our center [21]. These factors explain the majority of our patients presented with extensive disease and also a high rate of incidence of loss in follow-up. Despite the limited results, compared with other literature, there is no doubt that CWDM is still a gold standard for the treatment of cholesteatoma that showed a high percentage of dry ear postoperatively. MRM is a one-time operation that provides advantages to patients in the eradication of disease and hearing improvement, especially for patients with low socioeconomic status and poor follow-up.

Conclusion

Single-stage CWDM (MRM) is a preferred surgical treatment for extensive cholesteatoma, especially in poor compliance follow-up as it provided a high percentage of dry ear and maintained the functional hearing outcome.

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Authors' contributions
AN and WJB conceived the original idea. This was also discussed with IPT. AA contributed to the data analysis. Eventually, all the authors discussed and agreed with the focus and ideas of this paper. The main text of the paper was written by AN and WJB and edited by IPT. The authors revised the manuscript and contributed equally. The authors read and approved the final manuscript.

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Availability of data and materials
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Declarations

Ethics approval and consent to participate
This study approved by Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia (MOH) with reference number : NMRR-20-935-53982(IIR) in 2020. Consent to participate is not applicable as this was a retrospective study.

Consent for publication
Informed written consent was obtained from the participant or from their parent or legal guardian in the case of children under 16 for the publication of this study.

Competing interests
The authors declare that they have no competing interests.

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