MASTOID SURGERY OUTCOMES IN TWO TERTIARY MALAYSIAN HOSPITALS

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Abstract

Objective: Mastoidectomy is a surgical procedure of exenterating the mastoid air cell. The goal of this surgery is to create a dry, safe ear, to preserve or restore functional hearing as much as possible and to prevent complications. There are two types of mastoidectomy, each with their own indications, advantages, and disadvantages. It can be divided into canal wall up mastoidectomy (CWUM) and canal wall down mastoidectomy (CWDM). The objective of this study is to determine the outcome of both types of mastoidectomy in term of audiological and ear status for patients with chronic active otitis media (OM) with cholesteatoma, chronic mastoiditis or chronic active OM with cholesteatoma and mastoiditis managed at our tertiary centres; Universiti Kebangsaan Malaysia Medical Centre (UKMMC) and Kuala Lumpur General Hospital (KLGH). Design: A retrospective 10-year study was conducted at UKMMC and KLGH. Materials & Methods: All patients who were diagnosed with CSOM with / without cholesteatoma and/ or chronic mastoiditis and underwent surgical intervention during the study periods were included in this study. The age, gender, presenting symptoms, complications, diagnosis, surgical procedures and the surgical findings were retrieved from clinical notes. The postoperative pure tone audiometric (PTA) thresholds were

evaluated on the follow-up visit within six months to one year after surgery. Results: There were 253 patients recruited with 260 ears as study samples. 103 cases underwent CWUM and 157 cases underwent CWDM. At surgery, cholesteatoma was detected in 68% of the patients. We found 58.3% of ears in the CWUM group showed improvement in hearing threshold whereas only 44.6% showed improvement in the CWDM group. Post-operatively, mean PTA in CWUM (49.7dB) is significantly better than CWDM (59.2dB) with p value of 0.003. In CWUM, the mean air bone gap (ABG) is 24.05dB, which is significantly better than in CWDM (31.03dB). From all patients who underwent CWUM, 42% had post-operative ABG less than 20dB and this only occurred in 20.6% of the CWDM group. For ear status, 85% of patients who underwent CWUM had a dry ear postoperatively, which is significant compared to CWDM which was 69%. Conclusion: CWUM provides a better hearing outcome based on average air conduction (AC) threshold, AC gain and mean ABG. It also has a higher chance of obtaining a safe, dry ear.

Keywords: *hearing outcome, canal wall up, canal wall down, mastoidectomy, hearing loss*

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INTRODUCTION

The primary objectives in the surgical management of chronic otitis media with or without cholesteatoma is the eradication of disease, as well as ensuring a dry and safe ear. Hearing preservation or restoration is also worth considering but is often treated as a secondary goal. Controversies in surgical management of cholesteatoma include the choice in surgical approach, either CWUM or CWDM (Nikolopoulos & Gerbesiotis, 2009; Whittemore et al., 1998). Generally, the hearing results of CWUM are better than those of CWDM (Milan et al., 2008).

In CWUM, removal of the middle ear and mastoid disease is performed with preservation of the posterior canal wall. Modified Radical Mastoidectomy (MRM) is one form of CWDM. In MRM, the posterior canal wall is taken down till the level of the facial nerve and the floor of the mastoid cavity is continuous with the floor of the external canal. As a result, the mastoid cavity, epitympanum and external auditory canal are converted into a common cavity.

Several factors including age, otologic findings and hearing status both in the diseased and contralateral ear are important considerations for choice of surgical procedure in chronic active otitis media. Generally, factors that favour CWUM are in the cases of limited atticoantral disease with minimal hearing loss, intact ossicular chain and in well-pneumatized mastoids. Apart from that, patients with good compliance for follow up and pediatric patients are also suitable for CWUM. On the other hand, CWDM are relatively indicated in patients with extensive disease, poor hearing status, poor pneumatized mastoid and those cases with the presence of complications. (Dennis, 2000).

CWDM is advantageous as it is a single stage procedure that provides an excellent exposure of disease and good post-operative monitoring. Many studies suggested lower recurrence rates (5-15%) after CWD mastoidectomy and recurrences are usually easily identified in the outpatient clinic (Kos et al., 2004). Second-look operations are rarely necessary. However, this open cavity calls for lifetime maintenance as a consequence of a loss in the ability of self-cleansing that would result in accumulation of debris, granulation tissue formation with local infection and discharge (Cody et al., 1984).

CWUM has the advantage of leaving an intact external auditory canal without a mastoid cavity. However, the incidence of recurrence of cholesteatoma is high (20-50%), therefore, second-look operations after 12-18 months are necessary in almost all cases,

and some cases require further procedures subsequently. CWUM is technically more difficult and requires significantly longer operating time.

Despite being a common disease, chronic suppurative otitis media (CSOM) with or without cholesteatoma has been largely understudied. There is limited research regarding the disease epidemiology, clinical presentations, complication rate, surgical management and the outcome of the surgery. The aim of this study is to evaluate the outcome of both types of mastoidectomy in term of audiological and ear status for patients with chronic active otitis media (OM) with cholesteatoma, chronic mastoiditis or chronic active OM with cholesteatoma and mastoiditis managed at UKMMC and KLGH.

METHODOLOGY

This is a retrospective study, which was conducted at two Malaysian tertiary medical centers, which are UKMMC and KLGH from June 2007 to December 2016 to evaluate the outcome of mastoidectomy for chronic active otitis media (OM) with or without cholesteatoma and chronic mastoiditis. All patients who were diagnosed with CSOM with/without cholesteatoma and / or chronic mastoiditis and underwent surgical intervention at UKMMC and Kuala Lumpur General Hospital during the study periods were included in this study. All age groups including pediatric and adult patients were included. Patients who underwent mastoid surgery as an approach to other surgery such as cochlear implant, translabyrinthine approach for acoustic neuroma, all revision cases and patients with incomplete data/ loss of data documentation were excluded.

Patients medical records were reviewed to obtained the demography as well as the surgical outcomes of the patients. The age, gender, presenting symptoms, complications, diagnosis, surgical procedures and the surgical findings were noted. The postoperative pure tone audiometric (PTA) thresholds were recorded on the follow-up visit within 6 months to 1 year after surgery. Regarding the assessment of hearing status, three pure-tone averages were used for bone and air thresholds at the frequencies of 0.5, 1, and 2 kHz. In the case where postoperative PTA was unavailable, patients were given followed up for hearing assessment.

Patients were divided into the CWUM group and the CWDM group. The difference of the mean postoperative air conduction hearing threshold, air bone gap (ABG) and the ABG closure between the CWUM and CWDM groups were compared. The average air conduction gain was obtained by subtracting the preoperative of the three pure tone average (i.e. 0.5, 1 and 2 kHz) for air conduction from the postoperative air conduction of the same average of 3 pure tone frequencies. Air bone gap closure was calculated by subtracting the preoperative air bone gap from the postoperative air bone gap of 3 pure tone average (i.e. 0.5, 1 and 2 kHz). The air bone gap closure was categorized into three categories. Changes of ABG closure postoperatively were analyzed and patients were further grouped by 10 dB changes into: Improvement of ABG closure: <-10dB. No change: -10dB to 10dB. Worsening of ABG closure: > 10 dB. The data was analyzed using SPSS 12.0 for windows (SPSS, Chicago, IL). The Student *t*-test and chi-square test were used for statistical analysis. The level of statistical significance was set at $p < 0.05$.

RESULT

Demographics

There were 253 patients recruited with 260 ears as study samples. Seven patients had bilateral mastoidectomy were included as samples. The age of sample population ranged

from 5 years to 70 years old with mean age of 34 years. Male to female ratio is about 1:1 (45.5% females versus 58.2% males). Majority of the study population were Malays (58.5%), followed by Chinese (20.8%), Indian (15.4%) and others (5.4%). The racial distribution of the patients in this study reflects the racial distribution of the population in the country. Hundred thirty-six samples (56%) were collected from KLGH and 124 samples (47.7%) were collected from UKMMC from period of 1st June 2007 till 30th December 2016. There was almost equal distribution between the left and right ear. The left ear was affected in 50.4% of the patients and the right ear, 49.6% (Table 1).

TABLE 1. Demographic Frequency and Percentages

		FREQUENCY	PERCENT
Hospital	KLGH	136	52.3
	UKMMC	124	47.7
Age	<18	67	25.8
	>18	193	74.2
Sex	Female	118	45.4
	Male	142	54.6
Race	Malay	152	58.5
	Chinese	54	20.8
	Indian	40	15.4
	Others	14	5.4
Side of ear	Left	131	50.4
	Right	129	49.6
	Total	260	100

Presenting Symptoms

Otorrhea and reduced hearing were the commonest presenting symptoms accounting for 93% and 87.3%, respectively. This is followed by otalgia, blood stained ear discharge, vertigo and facial weakness (Figure 1). Previous study by Abdullah et al. (2012) and Milan et al. (2008) also reported similar commonest findings on the presenting symptoms.

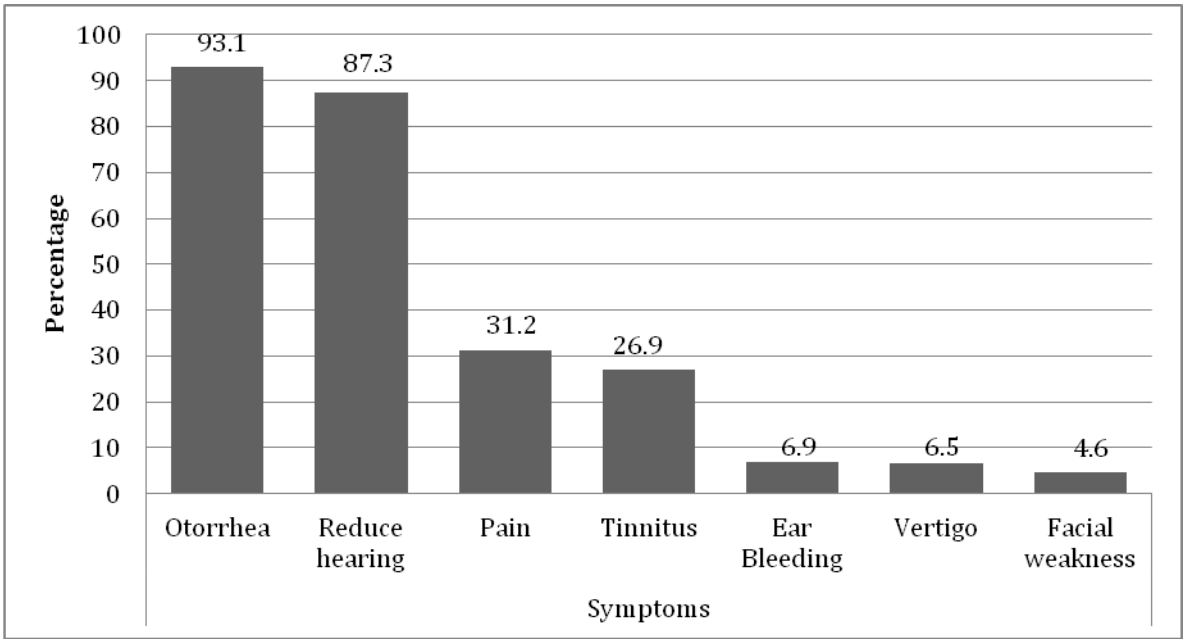

ILLUSTRATION 1. Distribution of Presenting Symptoms

Presence of Intracranial and Intratemporal Complications

In regards of disease complications, 28 patients (10.7%) presented with intratemporal complications (17 cases of facial nerve palsy, five cases with mastoid abscess, three cases of labyrinthitis, three cases of subperiosteal abscess. Seven patients (2.7%) presented with intracranial complications (three cases of brain abscess, two cases of lateral sinus thrombosis, one case of extradural abscess and one case of meningitis abscess). The present study showed that facial nerve palsy is the most common intratemporal complication of the disease. This was similar to a previous report (Mustapha et al., 2008). Brain abscess is the commonest intracranial complication. This is contrary to other study, which reported that meningitis was the most common intracranial complication (Liang et al, 2005).

Diagnosis

At surgery, cholesteatoma was detected in 68% of the patients. For the distribution of diagnosis, out of 260 cases, 65% of the patients were diagnosed with CSOM with cholesteatoma, followed by CSOM with mastoiditis and CSOM with both cholesteatoma and mastoiditis, which are 31.9% and 3.1% respectively.

15.4% patients with CSOM with cholestetoma, 16.7% patients with CSOM with mastoiditis and 50% of patients with both cholesteatoma and mastoiditis presented with complications.

Types of Mastoidectomy

From the 260 cases, 60.4% underwent CWDM whereas 39.6% underwent CWUM. In CWUM group, 29% underwent cortical mastoidectomy followed by 5.4% who underwent combined approach tympanoplasty, 3.2% atticotomy and 2.0% atticoantrostomy. In CWDM all cases underwent MRM and none underwent radical mastoidectomy. This is because in this study we excluded all revision cases and usually the surgeon tends to do preservation surgery as first line treatment.

TABLE 2. Distribution of Types of Mastoidectomy

		Frequency	Percent
CWUM (n=103)	Cortical mastoidectomy	76	29.0
39.6%	Atticomy	9	3.2
	Atticoantrostomy	5	2.0
	Combined approach tympanoplasty	14	5.4
CWDM (n=157)	Modified radical mastoidectomy (MRM)	157	60.4
60.4%	Radical mastoidectomy	0	0

Status of Ossicles

Regarding ossicular involvement, our series showed that the incus is the most common ossicle affected followed by the malleus and stapes (Figure 3). This is in agreement with past findings. At surgery, the ossicular chain was found to be intact in the majority (70.9%) of patients undergoing CWUM, whereas only 26% of CWDM patients had intact ossicular chains (Figure 2).

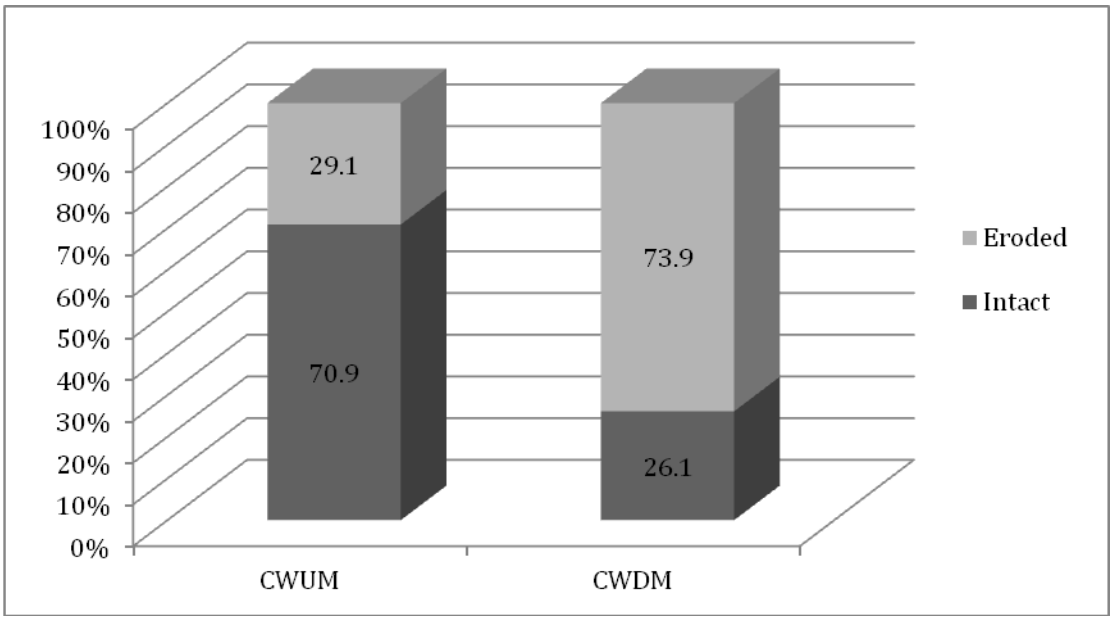

ILLUSTRATION 2. Status of Ossicles Found Intraoperatively between CWUM and CWDM group.

Hearing Status Post Mastoidectomy

Overall, our study showed in the majority of cases which is 62% (64 cases) maintained the pre-operative hearing level, 16% (17 cases) showed improvement and 21% (22 cases) had worsened AC hearing following CWUM. Similarly, in CWDM, majority of cases 66% (64 cases) maintained the pre-operative hearing level, 11% (18 cases) showed improvement and 20% (32 cases) had worsened AC hearing following CWDM.

TABLE 3. Group of Pre-Operative and Post-Operative Air Conduction (AC) Hearing Threshold in CWUM and CWDM

		Pre-op PTA					
CWUM		0-20 (Normal)	21-40 (Mild)	41-60 (Moderate)	61-90 (Severe)	> 91 (Profound)	Total (n)
Frequency	(n)	**7**	**33**	**33**	**26**	**4**	**103**
Post-op PTA	0-20 (Normal)	**4**	3	0	0	0	7
	21-40 (Mild)	3	**24**	4	3	0	32
	41-60 (Mod)	0	6	**23**	6	0	34
	61-90 (Severe)	0	0	6	**10**	1	17
	> 91 (Profound)	0	0	0	7	**3**	10

		Pre-op PTA					
CWDM		0-20 (Normal)	21-40 (Mild)	41-60 (Moderate)	61-90 (Severe)	> 91 (Profound)	Total (n)
Frequency	(n)	**2**	**47**	**50**	**38**	**20**	**157**
Post-op PTA	0-20 (Normal)	**1**	1	0	0	0	2
	21-40 (Mild)	1	**31**	3	3	0	39
	41-60 (Mod)	0	13	**40**	10	0	64
	61-90 (Severe)	0	2	7	**16**	4	30
	> 91 (Profound)	0	0	0	9	**16**	25

Post-Operative Air Conduction Hearing Gain

In CWUM 58.3% showed improvement in hearing gain whereas only 44.6% improvement observed in CWDM. The postoperative AC hearing gain of patients undergoing CWUM was significantly better than those of patients undergoing CWD procedure (p value 0.031). (Table 7)

TABLE 4. CWUM and CWDM post-operative air conduction hearing gain

		Group					
		CWUM		**CWDM**			
		N	%	N	%	χ^2	P
Pure Tone Average AC (Pre - Post)	**Improving**	60	**58.3**	70	**44.6**	4.65	0.031*
	Not improving	43	41.7	87	55.4		

Post Operative Mean Hearing

Post-operative Pure Tone Average (PTA) in CWUM is 49.7dB, which is significantly better than in CWDM, which is 59.2dB. (p value 0.003). For mean ABG, CWUM revealed 24.05dB, which is significantly better than in CWDM, which is 31.03dB. Pre-operative pure tone average in CWUM and CWDM is almost similar (54dB in CWUM and 56dB in CWDM). Postoperatively, CWUM showed improvement to 49.7dB whereby CWDM showed worsening of pure tone average to 59.2dB. Thus, average hearing improvement in CWUM is about 4.3dB.

TABLE 5. Post Operative Mean Hearing

	Group	**N**	**Mean**	**Std. Deviation**	**t**	**P**
Average PTA	CWUM	103	49.72	24.62	2.97	0.003*
	CWDM	157	59.21	25.63		
Average ABG	CWUM	95	24.05	12.80	4.12	<0.001*
	CWDM	136	31.03	12.59		

Pre-Operative and Post-Operative Air Bone Gap (ABG)

We found 42% of patients underwent CWUM had post-operative ABG less than 20dB and this only occur in about 21% of the CWDM group. These results were statistically significant for CWUM group (p value 0.011).

TABLE 6. Pre-Operative and Post-Operative Air Bone Gap (ABG)

		CWUM				**CWDM**			
		Pre		Post		Pre		Post	
		n	%	N	%	n	%	n	%
ABG	<10 dB	3	3.2	14	**14.7**	7	5.0	8	**5.9**
	11-20 dB	17	18.3	26	**27.4**	22	15.6	20	**14.7**
	21-30 dB	31	33.3	30	31.6	43	30.5	44	32.4
	31-40 dB	29	31.2	15	15.8	37	26.2	33	24.3
	>41 dB	13	14.0	10	10.5	32	22.7	31	22.8

(CWUM: Z -2.537[b], p value 0.011*)
(CWDM: Z -0.387[b], p value 0.700)

Air Bone Gap (ABG) Closure

In CWUM 18.6% showed improvement of ABG <10dB, 44.2% no improvement of ABG and 37.2% had worsening of ABG after surgery. Whereas, in CWDM, 29.7% showed improvement of ABG closure, 36.4% no improvement and 37.2% had worsening post surgery. This is statistically not significant. (Chi square: 3.32, p value: 0.068).

Ear Status Post Mastoidectomy

For ear status, dry ear was observed in 85% of CWUM group, which is significant compared to CWDM group, which is 69%. (Chi square 8.68, p value 0.003*) There were 10.7% of CWUM and 26.8% of CWDM patients had postoperative discharging ear. This might be contributed by the presence of granulation tissue, recurrent infection and residual disease. However, overall recurrence rate occurs in 7.0% (11 patients) of CWDM and 9.7% (10 patients) of CWUM.

For neo-tympanic membrane status, pre-operatively all patients had abnormal tympanic membrane (TM), which majority 66% of CWUM and 69% of CWDM showed perforated TM. Retracted in 25% if CWUM and 19% CWDM, followed by dull and partially seen TM. Post-operatively, both groups give good outcome, which accounted for 81.6% in CWUM group and 84.1% of CWDM group. The difference was statistically not significant (Chi square 3.08, p value 0.079). Small percentage of patients, 15.5% of CWUM and 12.1% of CWDM had perforated TM postoperatively which maybe due to residual or neo TM graft not taken.

DISCUSSION

Mastoidectomy can be defined as the surgical procedure of exenterating the mastoid air cell. The goal of this surgery is to create a dry, safe ear, to preserve or restore functional hearing as much as possible and to prevent complications (Bennett et al., 2006). There are two types of mastoidectomy, each with their own indications, advantages, and disadvantages. It can be divided into canal wall up mastoidectomy (CWUM) and canal wall down mastoidectomy (CWDM).

In general, CWUM is designed to maintain the normal anatomic contours of the mastoid. Several studies in the literature showed that there is considerable difference in the healing process. CWU procedures usually need a shorter time to heal in comparison to CWD methods that may take a longer time and a small percentage are never free of moisture problems (Hinohira et al., 2007). Other benefits of CWU technique is the maintenance of the self-cleaning ability of the ear. When a cavity is created, the ear is considered not waterproof and may impose significant lifestyle restrictions on the patient. Regular cleaning of the cavity may be required in CWD cases, depending on whether the cavity is healed, the size of the cavity, whether an adequate meatoplasty was created, and whether the cavity is round rather than bean shaped.

CWDM is the most widely used surgical method worldwide. It is supposed to be easier, of shorter duration, and usually necessitates less surgical experience than the CWU procedures, and has low recurrence and residual rates. The anatomic and functional outcome is satisfactory, and the rate of complications is acceptably low (Grewal et al., 2007). A tympanoplasty can be performed simultaneously (Kos et al., 2004). Certain factors are in favour of CWD surgery. This includes extensive disease to the posterior canal wall, severely contracted mastoid with low-lying tegmen and anteriorly placed sigmoid sinus preventing adequate visualization through a standard CWU approach. CWD procedure is claimed to be the solution for cholesteatomas in an only hearing ear and when there is a complication such as labyrinthine fistula (Hulka et al., 1998). Another relative indication for CWD mastoidectomy is failure of previous CWU procedures with recurrent cholesteatoma. Follow-up in CWD procedures is usually straight forward as recurrent or residual disease may be easily visualized in a mastoid cavity. Our treatment policy has been to perform CWDM in all cases of extensive disease involving the aditus ad antrum whereas limited disease or cholesteatomas just confined to the tympanic cavity and in chronically discharging ears without cholesteatoma have been subjected to CWUM.

In our series, otorrhoea (93%) and reduced hearing (87.3%) were the most common presenting symptoms. This is followed by pain, tinnitus, ear bleeding and facial weakness A previous study by Abdullah et al. (2012) and Milan et al. (2008), also reported similar findings on the presenting symptoms. The present study showed that facial nerve palsy is the most common intratemporal complication of the disease. This is similar to previous reports by Mustapha A et. al, 2008. Brain abscess is the commonest intracranial complication. This is contrary to other study, which reported meningitis as the most common intracranial complication (Liang et al., 2005).

Regarding ossicular involvement, our series showed that the incus is the most common ossicle affected followed by the malleus. This is in agreement to other studies (Joseph & Siba, 2001; Kurien et al., 1998). The finding that an intact ossicular chain was detected in 70.9% of ears undergoing canal wall up mastoidectomy and in only 26.1% of canal wall down cases illustrates the difference in the severity of pathology between these two groups.

In regards to hearing outcome, our study revealed following surgery a Pure Tone Average (PTA) of 49.7dB was achieved in CWUM, which is significantly better than in CWDM (59.2dB) with p value of 0.003. The average hearing improvement was 4.3dB in CWUM. 58.3% of patient in CWUM group showed improvement in hearing threshold whereas only 44.6% improvement observed in CWDM group. Thus, our findings showed that patient who underwent CWUM showed significantly better postoperative hearing levels than patients who underwent CWDM.

A previous study by Hirsch et al. (1991), demonstrated superior hearing outcome in a CWUM (76% versus 69% ABG closure less than 30 dB). The hearing loss occurring after middle ear or mastoid surgery was probably due to changes in the structure of the middle ear or cochlear damage. In a literature review of CWU and CWD, we found many that reported better audiometric results when the CWU technique was employed, rather

than the CWD technique (Segalla et al., 2008; Murphy et al., 1998; Vartianinen et al., 1992).

In contrast, a study by Min Beom Kim et al. (2010), showed that there was no difference of the postoperative hearing outcomes according to the types of mastoid surgery (CWUM vs. CWDM) in CSOM patients. Similar differences in hearing results between these two surgical methods have also been reported in some earlier study (Harkness et al., 1995). Wetmore et al. (1987) observed that the presence or absence of the posterior canal wall had no influence on hearing outcome. Another study reported that in the long run, hearing improvement after cholesteatoma surgery was marginal, regardless of the surgical technique used (Toner et al., 1990).

For a mean ABG, CWUM is significantly better than in CWDM, which is 24.05dB versus 31.03dB. 42% of our patients underwent CWUM had post-operative ABG less than 20dB and this only occur in about 21% of the CWDM group. Artuso et al., 2004, reported an improvement from the mean preoperative ABG of 28.44 dB to 24.06 dB in two years after CWD surgery for cholesteatoma. In regards to post operative ear status, our study showed 85% of patients had dry ears and 81.6% had intact tympanic membrane post-operatively which is slightly lower than the study published by Payal et al. (2004). They reported 95% waterproof ears postoperatively.

Generally, recurrence or residual cholesteatoma has been found to appear significantly more frequent after CWUM than CWDM, rendering some form of second look surgery necessary (Hassan et al., 2003). However, study by D. Brackmann et al. (2001), found little difference in the incidence of residual disease. In CWU procedures, recurrent cholesteatoma may result from a posterosuperior retraction pocket (Soldati & Mudry, 2000). The potential causes for discharging ear following CWDM include an insufficient meatoplasty, a high facial ridge, dependent mastoid tip cells, incomplete mastoid air cell removal, and retained/ residual cholesteatoma. Yung et al. (2007), recommended a spaced-out duration of five years or longer after surgery before assessing recurrence rate, postoperative otorrhoea and hearing outcome. Regardless of techniques used, the recurrence rates have been reported to be between seven and 57% (Goh et al., 2012; Ahn et al., 2003; Darrouzet et al., 2000). The overall recurrence rate in our series was 10%, most occurring after CWU procedures. The extent of ossicular erosions and disease in the anterior epitympanum, mastoid tip, sinodural angle, facial recess and or sinus tympani have been reported to be associated with residual or recurring disease (Roger et al., 1997; Rosenfeld et al., 1992).

Study Limitations

This is a retrospective study where data is based solely on documentation in case notes. We encountered missing data in almost 20% of cases due to poor medical record keeping. Thus, we suggest future research to include the revision cases and longer period of follow up and evaluate the long-term outcome of hearing.

CONCLUSION

CWUM provides better hearing outcomes based on average AC threshold, AC gain and mean ABG. It also has a higher chance of obtaining the goal of a dry and safe ear. Thus, we suggest CWUM approach as first line surgery despite the presence of cholesteatoma in selected diseased ears.

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