

## PROPORTION OF CAVITY PROBLEMS AND ITS ASSOCIATED FACTORS POSTMODIFIED RADICAL MASTOIDECTOMY IN PATIENTS OF ACTIVE SQUAMOSAL TYPE OF CHRONIC OTITIS MEDIA: AN ANALYTICAL CROSS-SECTIONAL STUDY

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### ABSTRACT

**Objective:** The objective of the study is to determine the proportion of cavity problems and their associated factors following modified radical mastoidectomy (MRM) in patients with active squamosal of type chronic otitis media (COM).

**Methods:** An analytical cross-sectional study was conducted in the Otorhinolaryngology Department of a tertiary healthcare institute in India. 65 patients who underwent MRM for active squamosal COM were included in this study. Patients were evaluated at 3 months postoperatively for cavity-related problems, such as persistent ear discharge, giddiness, hearing loss, dependency for cleaning of the mastoid cavity by means of detailed otological and audiological assessment, and bacteriological analysis of discharging cavities.

**Results:** Among the 65 patients, 26.2% reported otalgia, 23.1% had persistent ear discharge, and 23.1% experienced hearing loss at 3-month follow-up. Blocking sensation in the ear was noted in 15.4%. Giddiness and facial palsy were observed in 12.4% and 7.69% of cases, respectively. The study identified significant factors associated with cavity problems, including inadequate meatoplasty, high facial ridge, granulation tissue, unepithelialized cavity, and recurrent disease.

**Conclusion:** Post-operative cavity issues remain a prevalent concern, necessitating meticulous surgical technique and comprehensive post-operative care to improve outcomes. Identifying and addressing risk factors associated with persistent cavity problems can enhance patient recovery, reduce financial burdens, and improve overall quality of life.

**Keywords:** Chronic otitis media, Squamosal type, Modified radical mastoidectomy, Post-operative cavity problems.

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### INTRODUCTION

Open cavity mastoidectomy is a type of surgical procedure performed for managing chronic otitis media (COM) of the squamosal type. This procedure involves the removal of disease and the creation of a large enough meatoplasty to allow for a thorough examination. It provides a cavity which is epithelialized, dry, and self-cleaning and aids in maximizing hearing outcomes [1]. Modified radical mastoidectomy (MRM) has proven to be particularly effective for treating the squamosal type of COM. It is associated with fewer post-operative complications and offers maximal benefits, including better hearing outcomes [2]. It provides good exposure of the cholesteatoma intraoperatively, thus helping to eradicate the disease completely and making it easier to detect any recurrence postoperatively. This procedure significantly reduces the requirement for a second-stage operation, making it an economical option, particularly in resource-limited settings such as India [3].

Despite its benefits, approximately 20% of mastoid cavities remain unhealed 6 months after surgery, leading to various post-operative complications [4]. Incomplete healing and failure to achieve complete epithelialization can result in chronic discharging ears. The primary reasons for a discharging cavity include a high facial ridge, inadequate meatoplasty, uneven cavity, granulation tissue, and residual disease. These complications necessitate ongoing medical attention and can significantly impact the patient's quality of life. The success of the MRM in achieving a self-cleaning dry cavity largely depends on meticulous surgical technique and comprehensive post-operative care. Surgeons must ensure proper meatoplasty, smooth out cavity irregularities, and completely remove all disease tissues to promote optimal healing and

minimize complications. Post-operative management includes regular follow-ups to monitor healing and address any issues promptly.

The success of this procedure also depends upon patient factors such as infrequent cleaning of the ear, frequent upper respiratory tract infection, water contamination, eustachian tube dysfunction, and evidence of systemic diseases like diabetes mellitus [5].

Cavity problems post-MRM present a major health issue to patients and surgeons and several factors cause it, but there are very few studies in the medical literature regarding the estimation of the proportion of post-mastoidectomy cavity problems and its causes. Furthermore, sparse knowledge is available on the association of these factors with cavity problems after MRM. The maximum patients visiting the present tertiary care center belong to lower socioeconomic backgrounds and are from far-flung areas. Repeated visits to hospitals and long-term treatment add to their financial burden. Furthermore, by identifying cavity problems and a way to prevent or reduce them, improvement can be brought in the quality of life of patients.

Hence, this study was conducted with the aim of finding the proportion of cavity problems and their associated factors in patients of the Active squamosal type of COM who have undergone MRM.

### METHODS

A hospital-based 2-year analytical cross-sectional study was conducted in the Department of Otorhinolaryngology at a tertiary healthcare institute of India (NPK. Salve Institute of Medical Science and Research Centre and LMH, Digdoh Hills, Hingna Road, Nagpur,

Maharashtra) after approval from the Institutional Ethics Committee-EC/18/2022, October 27, 2022 (MUHS/PG/E-1/1503/27/2829/17, Dated-October 27, 2022). Patients of the active squamosal type of COM who underwent MRM and attended the Outpatient Department of Otorhinolaryngology for follow-up at the time of 3 months postoperatively were included in this study. The study period was 2 years, from November 2022 to October 2024.

#### Inclusion criteria

Patients of the active squamosal type of COM who underwent MRM and came for follow-up at the time of 3 months postoperatively were included in this study.

#### Exclusion criteria

Patients who had revision surgery or had intra-temporal or intracranial complications or who underwent MRM as an approach for other surgery such as for acoustic neuroma, facial nerve decompression, or malignancy of temporal bone were excluded. Patients having diabetes mellitus or on immunosuppressive drugs during surgery and follow-up period were also excluded as these conditions increase the healing time.

After obtaining valid consent, participants were recruited for the study using a convenience sampling method. The calculation of the sample size was done using the formula:

$$n = Z_{\alpha/2}^2 P (100-P) / L^2, \text{ yielding a sample size of 65.}$$

Where  $Z_{\alpha/2}$  is standard normal variate

P is proportion of recurrent discharge = 22%

L is absolute precision =  $\pm 10$ .

Otological examination (otoscopic and otomicroscopic) was done to evaluate the adequacy of meatoplasty, the status of mastoid cavity, facial ridge, middle ear mucosa and eustachian tube if visible, granulations, recurrence/residual disease. Tuning fork test was done for the evaluation of hearing status of patients. Pure Tone Audiometry and Impedance Audiometry were done for audiological evaluation. Bacteriological examination of pus from the mastoid cavity was done in participants having persistently discharging mastoid cavity. The following parameters were observed on otomicroscopy.

- Cavity problem – For the study purpose, a borderline healing period of 3 months was given for the complete epithelialization of an open mastoid cavity [6]. Any patient presenting with symptoms beyond this period was taken as a cavity problem case.
- Discharging mastoid cavity – Ear discharge was persistent after MRM even after 3 months of surgery [7] (Fig. 1).



Fig. 1: Left ear demonstrating discharging cavity after 3 months of modified radical mastoidectomy

- High facial ridge – Facial ridge above the level of floor of external auditory canal.
- Low facial ridge – Facial ridge up to the level of floor of external auditory canal.
- Adequate meatoplasty – Adequate or inadequate/stenosed meatoplasty allowing easy inspection of the mastoid cavity including sinodural angle, mastoid tip using a metal speculum size “3;” otherwise, it is labeled as inadequate or stenosed meatoplasty [5] (Fig. 2).
- Size of mastoid cavity – Mastoid cavity of volume of 5 cc was considered as a large mastoid cavity, 3–5 cc as medium and small <3 cc [8].

#### Statistical analysis

Mean and standard deviation were used to summarize continuous variables. The Fisher's exact test was used to find the association of various factors with the status of the mastoid cavity. All the analysis was performed using the software Epi Info version 7. A statistically significant p value was a  $p < 0.001$ .

#### RESULTS

A total of 65 subjects of active squamosal type of COM who underwent MRM who came for 3-month follow-up postoperatively were added to the study. Most of the subjects were between the age group of 21–30 years and the mean age of the study group was  $28.86 \pm 14.97$  years.



Fig. 2: Right ear with a wide meatal opening after 3 months of modified radical mastoidectomy

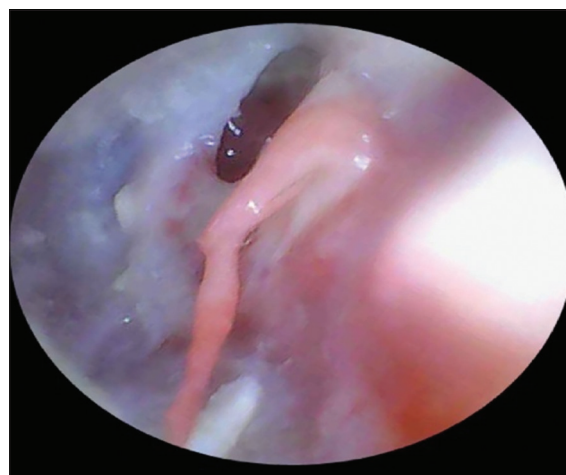


Fig. 3: Endoscopic photograph of the left ear demonstrating exposed middle ear (perforated neotympanum) after 3 months of modified radical mastoidectomy

There was no gender predominance having male: female ratio almost equal (1.03:1). Right ear MRM was done in 39 cases (60%) and left ear was operated in 26 cases (40%). Out of 65 patients, mastoid cavity was small in 50.79% of patients, medium in 41.53 % subjects, and large in 7.69% patients, which was measured intra and postoperatively during follow-up. 15 subjects (23.07%) had mastoid cavity problems and rest had settled cavity (76.92%). The present study evaluated the hearing outcome at a follow-up of 3 months after surgery. Improvement in hearing was observed in 24.6% of cases, while the majority, 58.4%, experienced no change in hearing status. However, hearing deterioration was noted in 16.9% of patients postoperatively.

Table 1 shows the distribution of subjects according to various mastoid cavity problems. The most common complaint was otorrhea seen in 15 subjects accounting for 83.3 % followed by wax in 7 cases (38.8 %). Facial palsy was seen in 5 cases (27.78%) and vertigo was seen in 4 cases (22.22%).

As shown in Table 2, in subjects of wet cavity group, the most common finding was exposed middle ear mucosa (perforation of neotympanum) (72.22%), followed by post-operative granulations (55.55%) and the unepithelialized cavity seen in 9 cases (50%). A high facial ridge and inadequate meatoplasty were seen in 22.22% and 11.11% subjects, respectively.

We tried to find the association of various factors with wet cavity postoperatively. In a wet cavity group, granulations were present in 67% subjects while none of the subject in dry cavity group had granulations. Although Fisher's exact test yielded a  $p < 0.001$ , indicating a statistically significant association between the presence of granulations and wet mastoid cavity, one of the table values is zero, reporting no relationship among the given variables (Table 3).

**Table 1: Frequency of various complaints related to mastoid cavity after MRM at the end of 3-month follow-up (n=18)**

Symptoms	No. of patients (n)	Percentage (total no. of points with cavity problems, n=18)
Otorrhea	15	83.3
Wax	7	38.8
Vertigo	4	22.22
Facial palsy	5	27.78
Residual disease/recurrence	0	0

Multiple observations present

**Table 2: Distribution of subjects with cavity problems according to otomicroscopic findings (n=18)**

Factors contributing to various cavity problems	Frequency (Percentage) n (%)
Post-operative granulations	10 (55.55)
Inadequate meatoplasty	2 (11.11)
High facial ridge	4 (22.22)
Exposed middle ear (perforation of neotympanum)	13 (72.22)
Large mastoid cavity	4 (27)
Unepithelialized cavity	9 (50)

**Table 3: Association of post-operative granulations with status of mastoid cavity at the end of 3-month follow-up**

Risk factors granulations	Wet cavity (n=15) (%)	Dry cavity (n=50) (%)	p-value
Present	10 (67)	0 (0)	<0.001
Absent	5 (33)	50 (100)	
Total	15 (100)	50 (100)	

Fisher exact test  $p < 0.001$  which is statistically significant

Table 4 shows that inadequate meatoplasty was present in 2 subjects (13%) having a wet cavity (out 18 subjects) but none of the subject within dry cavity group (47 subjects) showed inadequate meatoplasty. The Fisher's exact test yielded a  $p = 0.10$ , indicating that this association is not statistically significant. Furthermore, one of the table values is zero, reporting no relationship among the given variables.

As shown in Table 5, high facial ridge was found in 27% and 2% of subjects with wet and dry cavity, respectively. On statistical analysis by applying Fisher's exact test, it indicated a statistically significant association between a high facial ridge and a wet mastoid cavity ( $p \leq 0.05$ ).

Table 6 highlights the association between exposed middle ear mucosa, i.e., perforation of the neotympanum and the status of the mastoid cavity. In wet cavity group, 80% subjects had exposed middle ear mucosa as compared to 2% in dry mastoid cavity group. There was a statistically significant association between exposed middle ear mucosa and a wet mastoid cavity ( $p < 0.001$ ).

Large mastoid cavity was found to be statistically associated with wet cavity with  $p = 0.017$  as shown in Table 7.

An unepithelialized mastoid cavity was seen in 9 subjects with wet mastoid cavity while all the subjects with dry cavity had well-epithelialized cavity. The Fisher's exact test yielded a  $p < 0.001$ ,

**Table 4: Association of inadequate meatoplasty with status of mastoid cavity at the end of 3-month follow-up**

Inadequate meatoplasty	Wet cavity (n=15) (%)	Dry cavity (n=50) (%)	p-value
Present	2 (13)	0 (0)	0.10
Absent	13 (87)	50 (100)	
Total	15 (100)	50 (100)	

Fisher exact test -  $p = 0.10$  which is statistically non-significant

**Table 5: Association of high facial ridge with status of mastoid cavity at the end of 3-month follow-up**

High facial ridge	Wet cavity (n=15) (%)	Dry cavity (n=50) (%)	p-value
Present	4 (27)	2 (4)	0.04
Absent	11 (73)	48 (96)	
Total	15 (100)	50 (100)	

Fisher exact test  $p = 0.04$  which is statistically significant

**Table 6: Association of exposed middle ear mucosa (perforation of neotympanum) with status of mastoid cavity at the end of 3-month follow-up**

Exposed middle ear mucosa	Wet cavity (n=15) (%)	Dry cavity (n=50) (%)	p-value
Present	12 (80)	1 (2.08)	<0.001
Absent	3 (20)	49 (98)	
Total	15 (100)	50 (100)	

Fisher exact test  $p < 0.001$  which is statistically significant

**Table 7: Association of large mastoid cavity with status of mastoid cavity at the end of 3-month follow-up**

Large mastoid cavity	Wet mastoid cavity (n=8) (%)	Dry mastoid cavity (n=47) (%)	p-value
Present	4 (27)	1 (2)	0.017
Absent	11 (73)	49 (98)	
Total	15 (100)	50 (100)	

Fisher exact test  $p = 0.017$  which is statistically significant



**Table 8: Association of unepithelialized mastoid cavity with status of mastoid cavity at the end of 3-month follow-up**

Unepithelialized cavity	Wet mastoid cavity (n=8) (%)	Dry mastoid cavity (n=47) (%)	p-value
Present	9 (60)	0 (0)	<0.001
Absent	6 (40)	50 (100)	
Total	15 (100)	50 (100)	

Fisher exact test  $p < 0.001$  is statistically significant

indicating a statistically significant association between the presence of granulations and wet mastoid cavity (Table 8).

## DISCUSSION

COM of the squamosal type remains a significant health burden, particularly in developing countries like India, where access to specialized healthcare is limited. MRM is a widely accepted surgical intervention aimed at eradicating the disease and providing a safe, dry ear. However, despite its advantages, post-mastoidectomy cavity problems persist in a significant proportion of patients. The aim of the study was to evaluate the proportion of cavity problems and their associated factors in patients who underwent MRM for active squamosal-type of COM.

In the present study, the overall proportion of mastoid cavity problems was 27.69% (18 patients). The remaining 72.3% of patients (47 patients) had dry healthy cavity. These findings were consistent with the study of Rajan and James [9] (26.92%) and by Kumar and Kumar [10] (33.33%) after a healing period of 3 months. Incidence of cavity problems was 36% in Saraf *et al.* [6] study. They found otorrhea in 88% cases, wax in 55%, and giddiness in 11% cases. Our findings were consistent with the above studies. Malali *et al.* [11] in their cross-sectional study also reported discharging cavity in 75 % of the patients after a post-operative period of 3 months. Abdullah *et al.* [12] found discharging cavity in 41 patients (48.8%).

In Rajan's study [9], high facial ridge was present in 18 cases (85%) and post-operative granulations in 17 cases (80%), exposed middle ear mucosa in 80% of patients, large mastoid cavity in 5 cases (23.8%), and inadequate meatoplasty in 1 case (4.7%). Saraf *et al.* [6] found that the majority of the patients who had cavity problems showed most commonly tympanic membrane perforations (77%), high facial ridge in 2 cases (22%), and inadequate meatoplasty in 0 cases. A study by Kumar and Kumar [10] with 33.33% incidence of cavity problems showed exposed middle ear mucosa in 67.5% cases, high facial ridge in 30 cases (75%), large mastoid cavity in 9 cases (22.5%), granulations in 67.5% cases, and inadequate meatoplasty in 4 cases (10%). Malali and Rekha [11] noted persistent ear discharge in 75% of patients, attributing this to factors such as granulation tissue (35%), high facial ridges (26%), inadequate meatoplasty (10%), recurrence of disease (15%), and residual disease (14%). Our findings were in concordance with the above studies. Bhat and Vuppala [13] stressed that precise surgical practices, including circumferential saucerization and wide meatoplasty, are crucial to addressing post-surgical cavity problems. It showed granulations in 10% of the patients. Agarwala *et al.* [14] reported that out of 37 patients who underwent MRM, 5 patients had discharging cavity out of which 4 patients had granulations in the mastoid cavity and 1 patient had a granulation with residual cholesteotoma.

Sonvane *et al.* [15] out of 20 patients with discharging mastoid cavity post-MRM reported high facial ridge in 9 cases (45%), narrow meatoplasty in 11 cases (55%), and residual/recurrent cholesteotoma in 13 cases (65%).

Risk factors in our study which were found to be associated with cavity problems were the presence of post-operative granulation tissue, exposed middle ear mucosa (e.g., residual perforation or incomplete

neotympanum closure), and high facial ridge. Exposed middle ear mucosa was seen in 80% of patients with wet cavities, with a highly significant association ( $p < 0.001$ ). Inadequate epithelialization or persistent inflammation of the middle ear mucosa may contribute to recurrent infections and discharge. Anatomically, a high facial ridge may impede adequate cleaning and drainage of the cavity, leading to debris accumulation and secondary infection.

Although inadequate meatoplasty was more frequent among patients with cavity issues, the association was not statistically significant ( $p = 0.10$ ). Nevertheless, a wide and adequately exteriorized meatoplasty facilitates ventilation and cleaning of the cavity, reducing the likelihood of chronic otorrhea. Therefore, it remains an important surgical step, even if not statistically highlighted in this study.

Overall, the studies collectively suggest that canal wall down (CWD) mastoidectomy approaches can achieve effective disease management, with careful attention to surgical technique and patient follow-up being crucial for optimizing outcomes.

## CONCLUSION

This study highlights that despite the benefits of MRM, patients continue to experience cavity problems postoperatively. Enhanced surgical techniques, improved patient education, and stringent follow-up protocols can help mitigate these complications, ultimately improving patient outcomes and quality of life. Complete clearance of the disease is necessary. The cavity must be rounded and smoothly contoured with a low facial ridge so as to allow migration of epithelium. Ensuring proper epithelialization, addressing exposed middle ear mucosa, and managing infections are crucial to improving outcomes. In conclusion, the study highlights the importance of careful intraoperative and post-operative management to minimize mastoid cavity problems following MRM.

## Limitations

This study provided us with valuable insights; however, certain limitations must be acknowledged: Our study sample size was small ( $n = 65$ ). Larger multi-center studies are needed to validate the findings. The 3-month follow-up period of our study may not be sufficient to capture late complications such as recurrent cholesteatoma, warranting longer follow-up studies.

## AUTHOR CONTRIBUTION

Dr. Nitin Deosthale, Dr. Sonali Khadakkar, and Dr. Sanjeevani Mangade contributed to conceptualizing the research proposal, literature review, data collection and analysis, and manuscript writing. Dr. Vallabh Kulkarni has also contributed to the literature review, data collection, and analysis.

## CONFLICTS OF INTEREST

Nil.

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