

# Pediatric Modified Radical Mastoidectomy: Open Cavity versus Periosteal-Temporofascial Flap Obliteration: An Analysis

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**Abstract** Obliteration of the mastoid cavity leaves a smaller cavity with quicker as well as better healing. Chances of developing cavity granulations or infection are also reduced. Protection of the lateral semicircular canal by soft tissue obliteration also prevents vertigo episodes on exposure to cold air. This prospective study was to compare the results of pediatric modified radical mastoidectomy (MRM) in open mastoid cavities and cavities obliterated with periosteal-temporofascial swing flap at Manipal Teaching Hospital, Pokhara; a tertiary referral centre. The cohort comprised of 40 pediatric patients who underwent MRM between January 2012 and December 2014. They were divided into group 1 where mastoid cavity was kept open and group 2 where mastoid cavity was obliterated with periosteal-temporofascial swing flap plus medicated bone dust. Results in the 2 groups were assessed by comparing the time taken for mastoid cavity to become dry, incidence of vertigo on exposure to cold air, tympanic membrane graft status, mastoid cavity status and change in the pre-operative to post-operative pure tone average after 6 months. Statistical analysis was done with Statistical Package for Social Sciences (SPSS) version 16.0. Statistical significance was set at  $p < 0.05$ . Group 1 vs. Group 2 results were as follows: Mean time taken for mastoid cavity to dry was 81.8 days vs. 30.1 days. Vertigo on exposure to cold air was present in 77.3% vs. 0%. Tympanic membrane graft status was intact in 72.7% vs. 100%. Mastoid cavity epithelialization was complete in 68.2% vs. 94.4%. Mastoid cavity granulations were present in 36.4% vs. 5.6%. Mastoid cavity healing rates were 63.6% vs. 94.4%. Residual cholesteatoma was seen in 4.5% vs. 0%. Excessive wax & keratin debris was present in 36.4% vs. 5.6%. External auditory canal opening was adequate in 86.4% vs. 94.4%. The mean post-operative pure tone average was 37.61 dB vs. 25.97 dB. Mean gain in pure tone average was 8.94 dB vs. 19.84 dB. None of the patients developed intra-cranial complications. Periosteal-temporofascial swing flap plus medicated bone dust obliteration of pediatric MRM cavity provides a dry and healed cavity in less time with better hearing when compared to an open MRM cavity.

**Keywords:** periosteal-temporofascial swing, pediatric, modified radical mastoidectomy

**Cite This Article:** Vishal Sharma, Krishna Prasad Koirala, and Brijesh Sathian, "Pediatric Modified Radical Mastoidectomy: Open Cavity versus Periosteal-Temporofascial Flap Obliteration: An Analysis." *American Journal of Public Health Research*, vol. 3, no. 5A (2015): 174-177. doi: 10.12691/ajphr-3-5A-36.

## 1. Introduction

The problems with an open modified radical mastoidectomy (MRM) cavity are chronic ear discharge, hearing deficit of 30-40 dB, frequent visits for removal of keratin debris and vertigo caused by exposure to cold air. The frequent visits for cavity cleaning are particularly bothersome in pediatric patients. Obliteration of MRM cavity results in a smaller cavity with quicker as well as better healing. Chances of developing cavity granulations or infection are also reduced. Protection of the lateral semicircular canal by soft tissue obliteration also prevents vertigo episodes on exposure to cold air. A hearing aid is better tolerated in an obliterated mastoid cavity due to its small size and absence of ear discharge. The risks with

MRM cavity obliteration could be the difficulty in observing cholesteatoma recurrence and rapid development of intracranial complications beneath the obliterating tissue. Mosher [1] first used a pedicled post-aural skin flap in 1911 to obliterate the mastoid cavity. Pedicled periosteum over the mastoid process was then used by Jenkins [2] in 1925. Kisch [3] applied temporalis muscle grafts in radical mastoid operation in 1928. Muscle flaps were introduced by Rambo [4] via his temporalis musculoplasty in 1958.

## 2. Material and Methods

This study comprises of 40 pediatric patients who underwent modified radical mastoidectomy at Manipal Teaching Hospital, Pokhara between January 2012 and

December 2014. The study was performed after approval from the institutional review board at our hospital and taking written, informed consent from the parent or guardian of all patients.

## 2.1. Inclusion Criteria

1. Patient suffering from chronic suppurative otitis media, attico-antral (squamous) disease.
2. Underwent modified radical mastoidectomy with tympanoplasty.
3. Complete removal of cholesteatoma & granulations during surgery.
4. Age less than or equal to 12 years.
5. Minimum follow up period of 6 months after surgery.

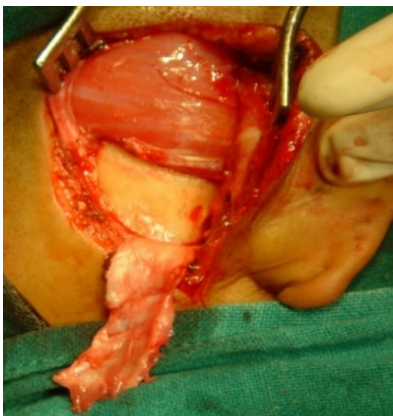
## 2.2. Exclusion Criteria

1. Underwent radical mastoidectomy.
2. Underwent revision modified radical mastoidectomy.
3. Underwent modified radical mastoidectomy without tympanoplasty.
4. Patient having an intracranial complication of chronic suppurative otitis media.
5. Bony erosion of sinus plate or dural plate or bone covering the Trautmann's triangle with granulations over the erosion.

Originally 45 pediatric patients who were planned for MRM were enrolled for this study. The patients were randomly divided into a Group 1 where mastoid cavity was kept open and a Group 2 where mastoid cavity was obliterated with periosteal-temporofascial swing flap and medicated bone dust. However 5 patients were later excluded from this study as they did not come for follow-up. Thus, 40 patients remained in the study with 22 in Group 1 and 18 in Group 2.

## 2.3. Surgical technique

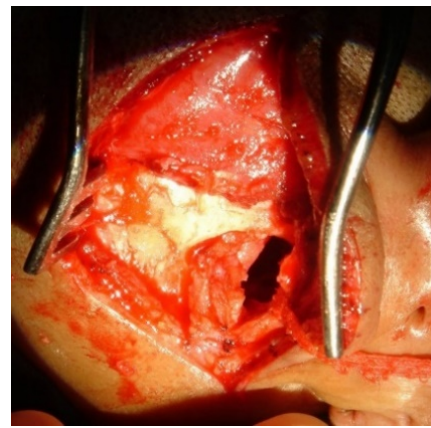
The surgeries were performed under general anesthesia via the post-aural incision. For Group 2 patients, skin flaps were elevated to fashion the periosteal-temporofascial swing flap. A large periosteal flap pedicled inferiorly was then incised and elevated in a supero-inferior direction, down to the mastoid tip (Figure 1).



**Figure 1.** Periosteal-Temporofascial Flap Elevated and Retracted Inferiorly

The periosteal segment of this flap was kept broad to almost fill the mastoid cavity. The flap pedicle over the mastoid tip contained the feeding vessel from post-

auricular artery. The flap was protected by rolling it in a moist gauze piece during the subsequent MRM procedure. Bone dust produced during drilling of superficial disease free mastoid cortex was collected, rinsed with sterile saline solution and kept soaked in Tobramycin ear drops. Adequate lowering of the facial ridge, breaking of facial bridge, complete clearance of cholesteatoma plus granulations and a good concho-meatoplasty were done. Mastoid cavity was partially obliterated with Tobramycin soaked bone dust and the lateral epitympanic defect was obliterated with conchal cartilage graft. Ossiculoplasty, if required, was done using conchal cartilage fashioned according to need. The swing flap was then rotated into final position with the periosteal part obliterating the mastoid cavity (Figure 2) and temporalis fascia part repairing the tympanic membrane defect as an underlay graft.



**Figure 2.** Periosteal-Temporofascial Flap Rotated Into Mastoid Cavity

For Group 1 patients MRM was performed followed by tympanoplasty to reconstruct the tympanic membrane and/or ossicular defect. No obliteration of the cavity or the lateral epitympanic defect were done. In both groups, packing of the ear cavity was done with gel foam pieces followed by closing of incision and application of mastoid dressing.

Follow up was done at 2 weeks, 3 weeks, 4 weeks, 6 weeks, 2 months, 3 months, 4 months and 6 months. During these visits, assessment was done by otomicroscopic examination. The hearing assessment was performed at the 6-month visit. 2% Gentian violet was applied in the mastoid cavity till its healing was complete. Results in the 2 groups were assessed at 6 months by comparing the time taken for cavity to become dry, incidence of vertigo on exposure to cold air, tympanic membrane graft status, mastoid cavity status and change in the pre-operative to post-operative pure tone average.

## 2.4. Statistical Analysis

All results were analyzed using Statistical Package for Social Sciences (SPSS) version 16.0. Statistical significance was set at a 2-sided p value <0.05.

## 2.5. Sample Size Calculation

In a pilot study done in 10 patients, Proportion in group 1 = .3, Proportion in group 2 = 1, Risk difference = -0.8, Power (%) = 95, Alpha Error (%) = 5, Side = 2, Required sample size for each arm = 9[5].

### 3. Results

Of the 40 patients in our study, 20 were males and 20 were females. The mean age was 9.22 years (sample standard deviation 1.88). The mean follow-up was 15.68 months for Group 1 and 13.0 months for Group 2.

The mean time taken for mastoid cavity to dry was 81.8 days in Group 1 and 30.1 days in Group 2 (Table 1).

**Table 1. Mean Time Taken for Cavity to Dry**

	Sample size	Mean time for cavity to dry (days)	Sample standard deviation
Group 1	22	81.82	28.65
Group 2	18	30.17	10.48

P value by independent samples T-test < 0.001

Vertigo on exposure to cold air was present in 77.3% of Group 1 and none of the Group 2 (Table 2).

**Table 2. Vertigo on Exposure to Cold Air**

Vertigo on exposure to cold air	Group 1		Group 2	
	Number of cases	%	Number of cases	%
Absent	5	22.7	18	100
Present	17	77.3	0	0
Total	22	100	18	100

P value by Chi-square (Fisher's exact) test < 0.001

Tympanic membrane graft was intact in 72.7% of Group 1 and 100% of Group 2 (Table 3).

**Table 3. Tympanic Membrane Graft Status at 6 Months**

Tympanic membrane graft status	Group 1		Group 2	
	Number of cases	%	Number of cases	%
Intact	16	72.7	18	100
Perforated	6	27.3	0	0
Total	22	100	18	100

P value by Chi-square (Fisher's exact) test = 0.024

None of the 6 cases of residual perforation in Group 1 agreed for revision tympanoplasty at a later date so they were asked to keep their ears dry

Mastoid cavity epithelialization was complete in 68.2% of Group 1 and 94.4% of Group 2 (Table 4).

**Table 4. Mastoid cavity epithelialization at 6 months**

Mastoid cavity epithelialization	Group 1		Group 2	
	Number of cases	%	Number of cases	%
Complete	15	68.2	17	94.4
Incomplete	7	31.8	1	5.6
Total	22	100	18	100

P value by Chi-square (Fisher's exact) test = 0.054

Topical Gentian violet solution was regularly applied in the cavities with patchy epithelialization.

Mastoid cavity granulations were present in 36.4% of Group 1 and 5.6% of Group 2 (Table 5).

**Table 5. Mastoid cavity granulations at 6 months**

Mastoid cavity granulation	Group 1		Group 2	
	Number of cases	%	Number of cases	%
Absent	14	63.6	17	94.4
Present	8	36.4	1	5.6
Total	22	100	18	100

P value by Chi-square (Fisher's exact) test = 0.027

Thus the cavity healing rates were 63.6% for Group 1 and 94.4% for Group 2. Granulations were cauterized with 20% silver nitrate along with instillation of antibiotic-steroid ear drops. Residual cholesteatoma was seen in one patient (4.54%) of Group 1 but none of the patients in Group 2. This patient was taken up for revision canal wall down mastoidectomy.

Excessive wax & keratin debris was present in 36.4% of Group 1 and 5.6% of Group 2 (Table 6).

**Table 6. Excessive wax & keratin debris at 6 months**

Excessive wax & keratin debris	Group 1		Group 2	
	Number of cases	%	Number of cases	%
Absent	14	63.6	17	94.4
Present	8	36.4	1	5.6
Total	22	100	18	100

P value by Chi-square (Fisher's exact) test = 0.027

These patients were regularly called to the outpatient department for microscope-assisted aural toilet.

External auditory canal opening was adequate in 86.4% patients of Group 1 and 94.4% of Group 2 (Table 7).

**Table 7. External auditory canal opening at 6 months**

External auditory canal opening	Group 1		Group 2	
	Number of cases	%	Number of cases	%
Adequate	19	86.4	17	94.4
Stenosis	3	13.6	1	5.6
Total	22	100	18	100

P value by Chi-square (Fisher's exact) test = 0.61

Three patients in Group 1 had membranous stenosis which was treated by a tri-radiate incision followed by packing of the external auditory canal with antibiotic-soaked ribbon gauze for 10 days. One patient in Group 2 also had stenosis which required division of the swing flap pedicle followed by meatoplasty. Regular aural toilet prevented further recurrence of stenosis in these patients.

The mean post-operative pure tone average at 6 months was 37.61 dB in Group 1 and 25.97 dB in Group 2. Mean gain in pure tone average was 8.94 dB in Group 1 and 19.84 dB in Group 2 (Table 8).

**Table 8. Mean gain in pure tone average at 6 months**

	Mean gain in pure tone average (dB)	Sample standard deviation
Group 1 (22)	8.94	1.30
Group 2 (18)	19.84	1.36

P value by independent samples T-test < 0.001

None of the patients developed intra-cranial complications.

### 4. Discussions

Several local pedicled flaps have been described for obliteration of mastoid cavity since the past 25 years. They are Palva flap [6] (meatally-based musculo-periosteal flap), Hong Kong flap [7] (inferiorly-based deep temporal fascia flap), temporalis myofascial flap [8], temporo-parietal fascial flap [9] (based on the superficial temporal fascia with superficial temporal artery pedicle), Singapore swing flap [10] (inferiorly based temporo-fascial-periosteal flap), post-auricular myocutaneous flap [11] (based on occipital



artery and sternocleidomastoid muscle), temporalis fascial flap pedicled on middle temporal artery [12], and inferiorly-based postauricular-periosteal-pericranial flap [13].

This study compares pediatric MRM results in open cavity (Group 1) vs. periosteal-temporofascial swing flap plus medicated bone dust obliteration (Group 2). Group 1 vs. Group 2 results in this study were as follows: Mean time taken for mastoid cavity to dry was 81.8 days vs. 30.1 days, as a smaller obliterated cavity tends to dry faster. Tympanic membrane graft status was intact in 72.7% vs. 100%. This happens due to the fact that the pedicled flap with its better blood supply leads to better chances of graft uptake. Mastoid cavity healing rates were 63.6% vs. 94.4% due to small size of the obliterated cavity. Mean gain in pure tone average was 8.94 dB vs. 19.84 dB. The better hearing gain in the obliterated cavity was due to the hearing deficit of 30-40 dB caused by the large open cavity.

Gibb et al [10] using the Singapore swing flap on 14 cases, reported a dry cavity in all and intact tympanic membrane in 11 cases. Wadhwa et al [14] compared 25 cases of periosteal-temporofascial flap mastoid obliteration with 25 cases of open mastoid cavity in adult patients. Mastoid cavity healing rates in the 2 groups were 84% and 60% respectively. Mean time of cavity healing was 8 weeks in obliteration group and 16 weeks in open cavity group. Vercruyssen et al [15] reported 52 cases of pediatric mastoid and epitympanic obliteration with bone pate. Recurrent cholesteatoma occurred in 1.9% and residual cholesteatoma in 15.4% of the cases. Hearing results showed a postoperative gain on pure-tone averages of 14.3 dB and a median air-bone gap of 25.6 dB. Sun et al [16] presented canal wall down mastoidectomy with mastoid obliteration in 45 children aged 5-12 years (48 ears). The recurrence rate and residual rate for cholesteatoma were 4.16% & 0% respectively. The mean air-bone gap closure was 17.2 + 2 dB. Singh et al [17] compared 26 cases of Singapore swing mastoid obliteration with 62 cases of open mastoid cavity in adult patients. Mean time taken for cavity to dry was 46 days in obliteration group, while it was 89 days in open cavity group. Gain in air conduction was 11-30 dB in 33.3% cases of obliteration group and 15.7% cases of open cavity group.

## 5. Conclusion

Periosteal-temporofascial swing flap plus medicated bone dust obliteration of pediatric MRM cavity provides a dry and healed cavity in less time with better hearing when compared to an open MRM cavity.

## Abbreviations

MRM = modified radical mastoidectomy  
SPSS = Statistical Package for Social Sciences

## Authors' Contribution

VS worked on study proposal, literature review, data collection, statistical analysis and manuscript preparation. KPK assisted in surgery & worked on manuscript review. BS helped with patient coordination & manuscript review. All authors read and approved the final manuscript.

## Declaration of Conflicting Interests

The authors declare that there is no potential conflicts of interest with respect to the research, authorship and /or publication of this article.

## Financial or Other Competing Interests

None.

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