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Original Research Article

Comparison of mastoid obliteration with middle temporal artery flap versus open cavity: a comparative study

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ABSTRACT

Background: The objective was to study the outcomes of the canal wall down (CWD) mastoidectomy patients in those with soft canal wall reconstruction by using middle temporal artery (MTA) flap in comparison to those with cavity left open.
Methods: A prospective study of 20 patients undergoing CWD surgery was done with 10 in each group of mastoid obliteration and open cavity. The outcomes were studied at 1, 3, 6 and 12 months post-surgery.
Results: At the final assessment of 12 months post op, the obliteration group had only 10% patients with grade 1 infection while open cavity group had 40% with grade 2 infection. Obliteration of mastoid cavity and reconstruction of canal wall with soft tissue MTA flap gave excellent control of infection.
Conclusions: The MTA flap is highly flexible and versatile for otologic reconstruction with an excellent arc of rotation and robust blood supply. It does not have the issues of resorption, dehiscence or fistula formation faced in other obliteration techniques.

Keywords: Middle temporal artery, Flap, Mastoid obliteration, Reconstruction, Open cavity, Canal wall down, Mastoidectomy, Cholesteatoma, Squamosal

INTRODUCTION

Schwartz in 1873 described cortical mastoidectomy with limited exenteration of mastoid air cells as a treatment for suppurative ear disease, which in that pre-antibiotic era proved remarkably efficacious.[1] It became evident that creating an open cavity was necessary for treating chronic otitis media (COM) with cholesteatoma and it was Zaufal in 1890 described radical mastoidectomy. It was modified by Bondy called as modified radical mastoidectomy (MRM) and these principles were extended by Jansen, Sheehy and Patterson who came out with the concepts of canal wall up and down mastoidectomies.[1]

Canal wall down (CWD) mastoidectomy is a standard method and one of the common management options for patients with cholesteatoma. But open cavity is anatomically and physiologically unsatisfactory. These patients may end up with problems like the need for regular cleaning of cavity and caloric effect may cause intolerance to water. Occasionally the cavity may become infected and cause otorrhoea when the lining breaks down.[2] Since there is a bare bone, skin does not grow readily and moist environment favours the growth of granulation tissue and mucosa. Hearing aids if required are also less tolerated in open cavity ears. These disadvantages have directed for considering eventual obliteration/rehabilitation of mastoid cavity.

Mastoid obliteration concept was first introduced by Mosher in 1911 and have continued to evolve since.[3] Obliteration is subdivided into 'filler' and 'flap' methods.[4] Filler techniques involve obliteration of the cavity dead space by the use of free grafts or other materials. Several materials have been used to reconstruct the posterior external auditory canal (EAC) as free grafts like cartilage, EAC bone and synthetic materials like silicone, proplast, ionomer cement ceravital and hydroxyl apatite. Reported complications after obliteration with synthetic material include infection, extrusion, resorption, myringitis, granulation tissue formation, recurrence of discharge, retraction pocket formation, recurrence of cholesteatoma, defect in external canal reepithelialisation, canal dehiscence and post-auricular fistula.[5]

Flap methods endeavour to rotate vascularised local soft tissue flaps into the defect. Smith et al who first reported soft-wall reconstruction, reconstructed the defects of the tympanic membrane and posterior EAC wall after removing the cholesteatoma with free soft tissue, such as a piece of the deep temporal fascia, while preserving as much of the posterior EAC wall skin as possible.[6] Many other variations of soft tissue reconstruction of the canal wall have been tried since then with different benefits. But they are not without problems. Attic obstruction and a narrowed meatus have been a traditional problem with anterior-based flaps.[5] Shrinkage problems were commonly encountered with posterior pinna based Palva-type flaps.[7]

Black and Kelly in 1994 originally described the version of middle temporal artery (MTA) flap which consists of periosteum based on the muscular branch of middle temporal artery.[8] MTA arises from superior temporal artery near the level of zygoma coursing superiorly at approximately 45º angle along the squamous temporal bone.[9] This is a highly vascular flap with retained flexibility, sufficient to fill the cavity space without blocking the adjacent mastoid antrum providing a waterproof skin lined canal with resistance to atrophy. This flap is still thin and pliable enough for the reconstruction of the canal wall rather than just lining the cavity for epithelialisation. It reduces the size of mastoid air cell system, increases the biological stability of the ear preventing the formation of new retractions in the neo-tympanic membrane. The purpose of our study was to study the outcomes of the CWD mastoidectomy patients in those with soft canal wall reconstruction by using MTA flap in comparison to those with the cavity left open.

METHODS

A prospective study was conducted in the Department of ENT and HNS, Command Hospital Air Force, Bangalore. After the acceptance of hospital ethical committee, the study was conducted from June 2016 to June 2018 over a period of 2 years. The study included all patients as per inclusion and exclusion criteria with chronic otitis media (COM) squamosal cases (new and revision cases).

Inclusion criteria

Inclusion criteria included both COM squamosal new and revision cases.

Exclusion criteria

Patients who are unfit or unwilling for surgery and doubt in clearance of cholesteatoma during surgery.

The entire study population included a total of 20 patients (n=20). A simple randomisation method was used to divide the study population to divide them into 2 groups. All odd number enrolled patients were allocated to the first group and even number patients to the second group. First group of patients underwent CWD mastoidectomies followed by middle temporal artery flap obliteration and the second group of patients were left with the open cavity. Informed written consent mentioning the type of surgery was obtained from the patients and appropriate counselling done.

Patients were followed up for a mean duration of 12 months (12-24 m), with the regular follow up at 1, 3, 6 and 12 post surgery. Photographs of the reconstructed canal or open cavity were taken during every scheduled visit for looking for flap status, atrophy or recurrence. Primary outcome was to provide patients with a safe, dry and self-cleaning cavity. Secondary outcome was to watch for post-op complications and the incidence of recurrent or residual cholesteatoma.

Patients who underwent surgery were assessed with the grading system developed by Merchant et al.[10] This semi-quantitative scale takes into consideration both patient symptomatology and clinical signs such as otorrhea and the presence of infection. The grade is defined as the worst score obtained at any point during the entire follow up. Grades 0, 1, and 2 are considered adequate control of infection, whereas grade 3 indicates failure of control of infection. grade 0 consists of those patients with no episode of otorrhoea or granulation tissue on otoscopy. Those with one episode of otorrhoea of <2 weeks duration in a 3-month period or a subjective feeling of wetness in the ear without otorrhoea are classified as grade 1. More than one episode of otorrhoea in a 3-month period or an episode of otorrhoea of >2 weeks or demonstration of localised granulation tissue or pus cured with conservative management will be grade 2. Grade 4 of the classification consists of those with constant purulent otorrhoea on a daily basis, or examination showing extensive granulation tissue, or need for a revision procedure to control infection.

The obliteration of the mastoid cavity using the middle temporal artery flap was planned with certain specific measures at the outset of the surgery.[11] Preparation for

the flap and hence its proper exposure with the preservation of the vascular pedicle is essential. The curvilinear incision was taken 1 cm behind pinna, superiorly from the attachment of helix of pinna till the mastoid tip below for better exposure during flap elevation. After the harvest of temporalis fascia as required, the temporalis muscle was dissected from the superficial soft tissue and with the deeper cranial periosteum. Care was taken to preserve the middle temporal vessels which forms the primary vascular pedicle of the flap to be created (Figure 1). Incisions were given posterior and superiorly, thereby creating a superiorly based flap based on MTA. Flap was rotated along its pedicle to cover the cavity created post canal wall down, and was inset with the periosteal layer facing the canal side for better soft canal wall and faster epithelisation. Special care is to be taken not to twist the pedicle of the flap but just to rotate it to prevent twisting the vessels. The reconstruction of the canal wall was completed with the proper stabilisation of this flap by keeping the cavity base uniform, edges saucerised and packed by gel foam on the canal side to keep the flap firm fixed against the cavity wall.

Statistical analysis was done using MS Excel 2013 developed by Microsoft corporation and IBM SPSS for Windows, Version 22.0, Armonk, NY Released 2013.

RESULTS

A total of 20 patients participated in this study of which 10 each were divided into group A and B. The age and sex of the patients of both the groups along with the status of their previous surgery for the same condition were collated and analysed (Table 1). The age of subjects in group A ranged from 12 to 65 with a mean age of 31.3, whereas the age of subjects in group B ranged from 25 to 60 with a mean age of 40.7. With regards to the gender distribution, group A had 70% males and 30% females, while the group B had 40% males and 60% females.

On further analysis, group A where middle temporal artery flap obliteration of the cavity was done had 70% of primary cases with 30% revision cases of squamosal disease. On the other hand, the group B where the cavity was left open had 60% primary cases and 40% of already operated cases of squamosal disease for revision. Statistically, there was no significant difference in the primary and the revision cases among the two groups.

All patients were regularly followed up and assessed at 1, 3, 6 and 12 months post-surgery using the summary grade as per our planned protocol. The summary grade is defined as the worst score obtained at any point during the entire follow up. The findings with respect to the status of their ear canal/open cavity and otorrhoea were noted including the assessment for residivism and compared between the two groups (Table 2). There were 30% of cases with infection upto grade 1 in the group A at the 1st month post-op, which decreased to 20% at the 3rd and 6th month post-op and finally at the end of 12 months post operatively, only 10% of the cases of group A had infection of grade 1, with 90% cases having complete dry and infection free ear. Whereas in group B, 50% of the cases had infection of grade 3 and 10% cases had giddiness at 1-month post op, which remained same in numbers at the end of 3 months with the grade of infection decreasing to 2. Further, 40% of the cases continued to have infection at the end of 6 months and even in the final assessment at the end of 12 months post operatively to the severity of grade 2 (Figure 2). Among the two groups, there was significant difference in the number of patients with post-operative infection and its severity in each of the assessed timeline, with superior infection control in group A.

There was no residual or recurrence of cholesteatoma in any of the patients of both group A and group B till the final assessment at the end of 12 months post-surgery. The status post MTA flap obliteration at the end of 12 months follow up of some Group A patients were as in the pictures (Figure 3-8). The patients represented in Figure 3-7 had good infection control of grade 0 and the one patient who had status of grade 1 infection was as in Figure 8.

Table 1: Patient details of group A and B.

S. no.	Group A - MTA obliteration		Group B - Open cavity	
	Age (yrs)/sex	New (N) or revision (R)	Age (yrs)/sex	New (N) or revision (R)
1	12/M	N	37/F	N
2	20/M	N	40/M	N
3	33/F	R	29/F	R
4	19/M	N	48/M	N
5	28/M	N	25/F	N
6	24/M	R	32/F	R
7	30/F	N	55/F	N
8	53/F	N	53/M	N
9	65/M	R	28/M	R
10	29/M	N	60/F	R

Table 2: Outcome comparison between Group A and B with grading by Merchant et al.[10]

Follow up post-op timeline	Ear infection			
	Group A - MTA obliteration group		Group B - Open cavity group	
	% of patients	Grade of infection	% of patients	Grade of infection
1 month	20%	1	50%	3
	Suture site infection – 10%		Giddiness – 10%	
3 months	20%	1	50%	2
			Giddiness – 10%	
6 months	20%	1	40%	2
12 months	10%	1	40%	2
Overall	No residual / recurrent cholesteatoma in either group			

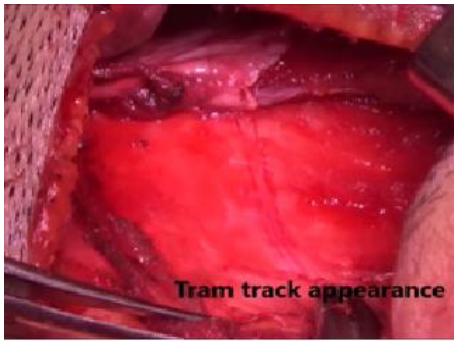

Figure 1: Middle temporal artery seen as tram track appearance during the flap elevation part of surgery.

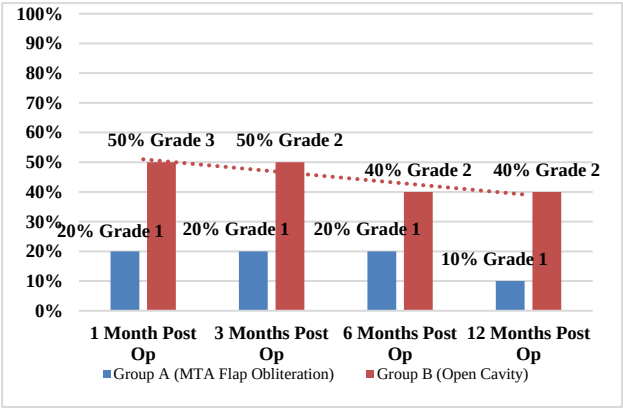

Figure 2: Post-operative ear infection status in group A and B.

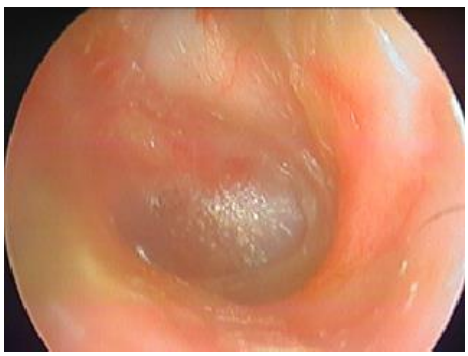

Figure 3: Post-operative status of patient 1 (after 12 months of surgery).

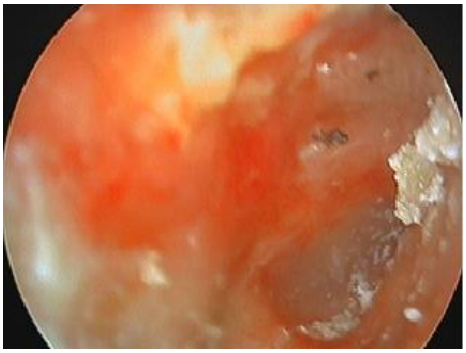

Figure 4: Post-op status of patient 2 (after 12 months of surgery).

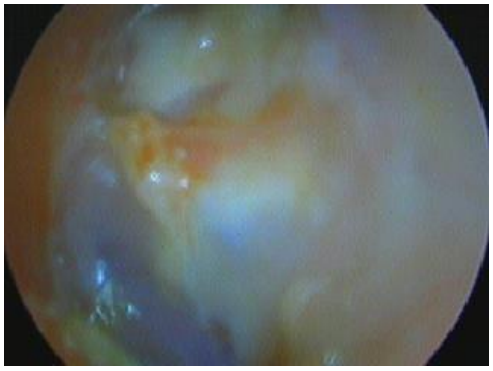

Figure 5: Post-operative status of patient 3 (after 12 months of surgery).

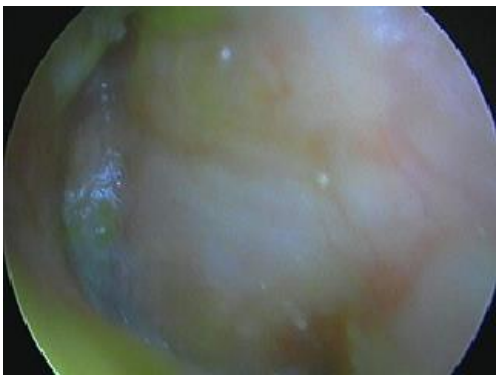

Figure 6: Post-operative status of patient 4 (after 12 months of surgery).

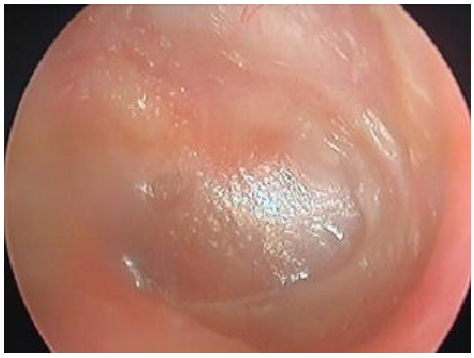

Figure 7: Post-operative status of patient 5 (after 12 months of surgery).

Figure 8: Post-operative status of patient 6 (after 12 months of surgery).

DISCUSSION

The CWD mastoidectomy is an established treatment method for cholesteatoma cases but the patients had their significant post op difficulties in various aspects. Hence the need for identifying and validating a better treatment methodology which does not compromise the clearance of disease but without the earlier disadvantages always existed. Our study had equal number of subjects in either study groups, selection done by randomisation without any bias. The age group of patients ranged from 12 to 65 years in group A and 25 to 60 years in group involving both the sexes. Both the study groups had similar representation of having revision cases as well.

Our focus in the study group A patients was to achieve a soft tissue canal wall reconstruction by the MTA flap that would give a dry, safe ear with appropriate canal size that would remain static over time and not resorb, dehisce or get infected. During the post-operative follow up at 1, 3 and 6 months, 80 % of group A patients had excellent infection control of grade 0 and only 20 % had grade 1 post op infection. Whereas those of group B who had open cavity poor infection control of grade 3 in 50 % of the patients in the 1st month and grade 2 infection in 50% and 40 % patients during the 3rd and 6th month follow up respectively. Further 10% patient had giddiness till 3rd month follow up that resolved later on. At the final follow up as per our study at 12th month, MTA flap reconstructed group had 90% complete control of grade 0 and only 10% patients had grade 1 status whereas the open cavity group had 40% patients with grade 2 status. Both the study groups did not have any recurrence of disease during the 12 month follow up period.

The literature search gave various studies on reconstruction of the cavity using similar flaps, fillers and combined techniques. Vivian et al used axial superiorly based MTA flap with an inferiorly based random pedicled musculoperiosteal flap for mastoid obliteration.[12] Of 51 patients who underwent the procedure, 43 (84%) had a small dry healthy mastoid cavity and 3 ears had occasional otorrhoea. Saunders et al used palva flap in 28 patients with chronically draining ears from 1987-1990.[13] Twenty six patients (93%) had successful tympanic membrane reconstruction with dry ears and two (7%) had persistent perforation with otorrhoea. Gantz et al used palva flap with bone chips, bony pate, silastic sheeting and temporalis fascia graft.[14] Ninety eight and half percent of 130 ears remained dry without recurrent disease. The outcome of the above studies ranged from 84% to 98% corresponding to our results of 90% infection free status.

Charachon et al used palva flap in 199 patients.[15] 97% achieved tympanic membrane closure, 17% had residual cholesteatoma, removed during the second look and late residual cholesteatoma occurred in 5 cases. Our study did not show any recurrence in cholesteatoma in both the study groups. The recurrence depends on various complex factors including the execution of the canal wall down procedure, the extent and severity of the disease.

Minatogaua et al reported extrusion of hydroxyapatite granules with a local inflammatory response and uncontrollable secretions.[16] Mahendran et al described the use of hydroxyapatite cement for mastoid obliteration.[17] There was a significant incidence of postoperative infection with 50% of the patients requiring revision surgery and removal of the foreign material. The study of Rosenblunt et al on silicone implants in the mastoid portion of the temporal bone showed considerable foreign body reaction with silicone.[18] Reck et al studied on Bioactive glass ceramics in middle ear surgery which had infection, absorption, lysis with ceravital, while encephalopathy was encountered with ionomer cement.[19,20] None of these complications encountered in the filler techniques were seen in our MTA reconstruction patients validating again the significance of flap techniques.

CONCLUSION

The decision to proceed with mastoid obliteration is made with careful consideration of the risk for disease recurrence, the reliability of patient follow up and an understanding of how the procedure will affect disease surveillance. The patients with soft canal wall reconstruction by the Middle temporal artery flap had

significant better outcome with high infection control and minimal incidence of discharge, dizziness and wax formation as compared to open cavity ears. The common issues encountered with other methods like atrophy, stenosis or resorption were never seen in our flap reconstruction. The middle temporal artery flap is highly useful for otologic reconstruction with an excellent arc of rotation and robust blood supply. It is quite versatile and flexible in choosing the necessary length and thickness to reconstruct the canal even in large mastoidectomy cavities.

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