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Hearing outcomes in canal wall up versus canal wall down mastoidectomy

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Abstract

Introduction: Chronic suppurative otitis media (CSOM) is a common condition with significant morbidity and psychosocial impact. Surgical management, primarily canal wall up or canal wall down mastoidectomy, is chosen based on surgeon preference, patient factors, disease extent, and hearing outcomes. The aim of the present study was to compare the hearing outcomes and graft take up rate between canal wall up and canal wall down mastoidectomy procedures.

Methods: The present prospective study was conducted in the Department of Otorhinolaryngology and Head Neck Surgery, a tertiary care multi-speciality teaching hospital from October 2020 to August 2022. The study group included 100 patients. In this study, all the patients underwent mastoidectomy with tympanoplasty using temporalis fascia graft. Intact canal wall mastoidectomy was done in patients with localized cholesteatoma while canal wall down mastoidectomy was done in patients having extensive disease. Regular follow up was done every week for first 3 weeks, later at 6th week, 3rd month, 6th month and 1 year.

Results: A total of 100 patients were included in the study. The age of the patients 10 to 50 years with a mean age of 18.7±15 years with male to female ratio 7:10. In the present study, graft take up in canal wall up mastoidectomy was 66.6% as compared to 33.4% in canal wall down procedure which was significantly higher (X^2=10.72, p= 0.0011). Hearing gain in canal wall up procedure (17.02±8.51db) was higher as compared to canal wall down mastoidectomy (10.3±6.98), (t= 4.22, p <0.001). It was statistically significant. Recurrence was seen in 1 patient who had undergone canal wall up surgery.

Conclusions: Canal wall down mastoidectomy is a safer option in the matter of residual disease and recurrence. Canal wall up surgery though may need a second look procedure, but there are better results of graft take up rate and the post-operative hearing as compared to canal wall down procedure

Keywords: chronic suppurative otitis media, hearing, canal wall up mastoidectomy, canal wall down mastoidectomy.

Introduction

In our society, chronic suppurative otitis media (CSOM) accompanied by hearing loss and otorrhea is seen in numerous patients. It has been an enduring problem with high rate of morbidity and psychosocial impact. In some patients, serious intra-cranial complications can occur. The aim of the treatment is to achieve a dry, safe ear with eradication of the disease and restoration of as much hearing as possible. The mainstay of management remains surgical. The two surgical techniques used globally for management of patients with middle ear cleft pathology are canal wall up and canal wall down mastoid surgeries. Deciding factors for type of procedure done depend on; the interest of operating surgeon, patient's general health and age, extent and type of pathology in the middle ear.

The open or modified radical mastoidectomy is the mainstay of surgical management of active squamous otitis media or cholesteatoma for last one and a half centuries [1]. For removal of chronic middle ear and mastoid disease modified radical mastoidectomy

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provides safer surgical access but comparatively hearing may not be as good as that after intact canal wall mastoidectomy [2, 3].

Various studies have been done for comparison of outcomes of canal wall down and intact canal wall mastoidectomy. Intact canal wall mastoidectomy has its advantage in preservation of posterior canal wall, which eludes water precautions and long term follow up for cleaning as compared to patients with open cavity, and the disadvantage in its need for a second look procedure to assess for any recurrence or residual disease.

Advances in surgical techniques and refinement in instrumentation have significantly improved the outcomes of mastoid surgery over recent decades. Despite these developments, the debate regarding the ideal approach remains unresolved, as each technique carries inherent advantages and limitations. The decision often requires a balance between achieving long-term disease eradication and ensuring optimal functional hearing outcomes. Patient-centered factors, such as lifestyle, occupational needs, and compliance with follow-up care, also play a critical role in surgical planning. Therefore, comparative studies analyzing anatomical and functional results continue to be essential for guiding evidence-based clinical practice.

The aim of the present study was to compare the hearing outcomes and graft take up rate between canal wall up and canal wall down mastoidectomy procedures.

Materials and methods

The present prospective study was conducted in the Department of Otorhinolaryngology and Head Neck Surgery, Government Medical College and Hospital, Jammu from October 2020 to August 2022. It was a comparative study. The study included 100 patients, of either sex, between 10- 50 years of age, having evidence of unilateral or bilateral attico-antral (squamosal disease) disease or cholesteatoma in the middle ear cleft, and those with good cochlear reserve. Patients with sensorineural deafness, systemic diseases (Hypertension, Diabetes Mellitus), having any active infection in the nose, throat and paranasal sinuses, or otogenic intra-cranial complications were excluded. The study was approved by institutional ethical committee. The informed written consent was obtained from all the patients or their legal guardian in case of patient being less than 18 years.

A written informed consent was taken from all the patients included in the study. The patients were subjected to detailed history, general as well as systemic examination which included clinical examination of ear, nose, para-nasal sinuses, larynx and pharynx. Patients underwent all routine examinations, the otologic examination and examination, examination under microscope to assess the exact nature and extent of the disease and any complications. In all patients, x-ray mastoids Schuller's view was done, HRCT bilateral temporal bones was done as and when indicated. Pure Tone Audiometry was done once before the surgery, then post-operatively at 6th week, 3rd month and 6th month follow up.

Operative procedure

General anaesthesia along with local infiltration of 2% lignocaine with adrenaline was done end-aurally and post-aurally. Korner's flap raised. The temporalis fascia graft harvested using a post-auricular incision, mastoidectomy was done based on the extent of the disease, tympanoplasty was done using autologous temporalis fascia and ossicles [4].

Canal wall up mastoidectomy was performed in cases with localized cholesteatoma, and in this group most of the patients underwent type 1 tympanoplasty. In cases with extensive disease, i.e., choleasteatoma involving mastoid, anterior epitympanum, sinus tympani, canal wall down mastoidectomy was done. Also in this group most of the patients had ossicular erosion so, type 3b or type 3c tympanoplasty was required. Ossicular reconstruction was done using conchal or tragal cartilage. Mastoid obliteration was not performed.

The study group included 100 patients. In this study, all the patients underwent mastoidectomy with tympanoplasty using temporalis fascia graft. Intact canal wall mastoidectomy was done in patients with localized cholesteatoma while canal wall down mastoidectomy was done in patients having extensive disease. Regular follow up was done every week for first 3 weeks, later at 6th week, 3rd month, 6th month and 1 year.

Statistical analysis

All the collected data was entered in the Microsoft excel sheet and then analysed using computer software Open Epi (version3) for window. The qualitative data and quantitative data were reported as proportions and mean (±SD), respectively. X^2 test and t-test was used to test the association. A p-value less than 0.05 was considered as significant. All p-values were two tails.

Results

A total of 100 patients were included in the study. The age of the patients 10 to 50 years with a mean age of 18.7±15 years with male to female ratio 7:10. In the present study, out of 100 patients, maximum number

of patients 41, belonged to age group 11-20 years, with 58 females 42 males. Age and sex distribution of the patients has been shown in table 1 and table 2.

Table 1: Age and sex distribution of the patients.

Age group(years)	*Sex*	
	Male (%)	*Female (%)*
0-10	6(14.2)	7(12.06)
11-20	19(45)	22(37.9)
21-30	3(7.14)	11(18.9)
30-40	5(11.9)	8(13.7)
40-50	9(21.4)	10(17.2)

Table 2: Age and sex distribution of the patients according to the mastoidectomy procedure.

Age group (years)	*Canal wall up mastoidectomy*		*Canal wall down mastoidectomy*	
	Sex		*Sex*	
	Male (%)	*Female (%)*	*Male (%)*	*Females (%)*
0-10	4(7.01)	4 (7.01)	2(4.6)	3(6.9)
11-20	8(14.03)	15(26.31)	11(25.5)	9(20.9)
21-30	2(3.5)	7(12.28)	1(2.3)	4(9.3)
31-40	2(3.5)	6(10.5)	3(6.9)	2(4.6)
41-50	4(7.01)	5(8.8)	5(11.6)	3(6.9)
Total	20(35.08)	37(64.9)	22(51.16)	21(44.18)

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In the present study, all the patients underwent mastoidectomy with tympanoplasty using temporalis fascia graft. Intact canal wall (ICW) or canal wall up mastoidectomy (CWU) was done in 57 patients (20 male and 37 female) with localized cholesteatoma. Intra-operative picture of a patient undergoing cortical mastoidectomy has been shown in figure1.

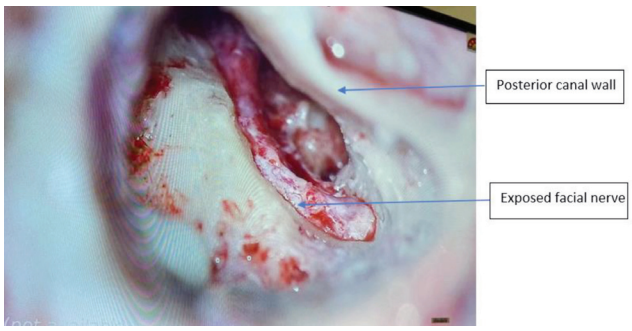

Figure 1: Intra-operative picture in canal wall up mastoidectomy showing exposed facial nerve.

Canal wall down (CWD) mastoidectomy was done in 43 cases (22 males and 21 females) having extensive disease as shown in figure 2; and maximum patients were in the age range of 11-20 years in both the groups as summarised in table 2.

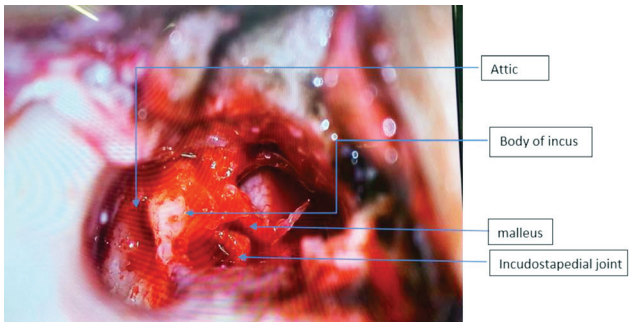

Figure 2: Intra-operative picture of a patient during canal wall down mastoidectomy.

In the present study, graft take up in canal wall up mastoidectomy was 66.6% as compared to 33.4% in canal wall down procedure which was significantly higher (X^2=10.72, p= 0.0011) as shown in table 3. Hearing gain in canal wall up procedure (17.02±8.51 db) was higher as compared to canal wall down mastoidectomy (10.3±6.98), (t= 4.22, p <0.001) which has been summarized in table 4. It was statistically significant.

Table 3: comparison of graft take-up between CWU and CWD mastoidectomy. (At 6 months follow-up).

Type of surgery	*No. of patients*	*No. of graft take up*	*Graft take-up (%)*	*X^2-value*	*p-value*	*95% C.I. for difference*
Canal wall up mastoidectomy	57	38	66.6	10.72	0.0011	(13.43% to 49.54%)
Canal wall down mastoidectomy	43	15	33.4			

Table 4: comparison of hearing gain between ICW and CWD mastoidectomy (At 6 months follow-up).

Type of surgery	*No. of patients (N)*	*Hearing gain Mean ±SD*	*t-value*	*p-value*	*95% C.I. for difference of means*
Canal wall up mastoidectomy	57	17.02±8.51	4.22	<0.001	(3.55 - 9.88)
Canal wall down mastoidectomy	43	10.3±6.98			

According to the frequency, comparison of air conduction thresholds was also done. Post- operatively, average air conduction threshold improvement was seen in 500 Hz, 1000Hz, and 3000 Hz, but no significant improvement was seen in 2000Hz.

Recurrence was seen in one patient (male, 18 years) who had undergone canal wall up surgery.

Discussion

The management of chronic suppurative otitis media is by and large surgical and it encompasses removal of all the diseased mucosa from the middle ear cleft and restoration of as much hearing as possible. The purpose of canal wall down procedures is to exteriorize the mastoid cavity for future monitoring of recurrent cholesteatoma and provide exposure to difficult access areas of temporal bone. In intact canal wall mastoidectomy on the other hand, posterior canal wall of external auditory canal is preserved. The pitfall of this procedure is that a residual cholesteatoma within middle ear or mastoid space may grow asymptomatically. So, most of the surgeons recommend a second look surgery.

In the present study hearing outcomes were better in canal wall up surgery as compared to the canal wall down surgery. Severity and extension of the disease is the most important deciding factor in choosing the type of surgical procedure to be done and hence it effects the hearing outcomes. Also, hearing outcomes are also affected by the status of middle ear mucosa, as in canal wall up surgery; the more of middle ear mucosa is healthy and preserved as compared to canal wall down surgery [5]. In the present study, severity and extension of the disease were classified as: extensive disease-involving multiple middle ear cleft subsites or significant mastoid involvement; severe disease included cases with widespread pathology along with ossicular erosion. Ossicular status was not recorded for each patient and is acknowledged as a limitation of the present study.

In canal wall up surgery, air cells in the mastoid cavity are removed and the mastoid cavity is connected directly to the middle ear through the aditus ad antrum; therefore, the volume of middle ear cavity is increased. Whereas, in canal wall down surgery, by removing the canal wall and the mastoid air cells, middle ear cavity becomes shallow, and the volume of middle ear is decreased, the external auditory canal and mastoid cavity are converted into a single cavity which is larger than the canal wall up surgery. These different surgical procedures, hence, result in acoustically better middle ear structure and change of external ear resonance [6]

Studies by Paparella et al.1989 [7], Hirsh et al,1992 [6] reported better hearing outcomes with canal wall up surgery which is similar to the present study. The findings of the present study were also consistent with the study conducted by Bhat PS et al, [4] which also showed similar results. In contrast studies done by Sade J, and Tos M et al, [7, 8] reported no significant difference between hearing outcomes in canal wall up and canal wall down surgery.

In the present study, graft take up in canal wall up surgery was significantly higher than canal wall down surgery. Graft take up also depends on type of the graft taken, patient factors like general health of patient, metabolic factors, smoking status; also on the size and thickness of the graft. Mostly temporalis fascia graft is used. In canal wall up surgery, graft take up is better because there are no or lesser cavity related problems as compared to the canal wall down surgery. Also, epithelialisation is faster and better in canal wall up surgery and hence better graft uptake. However, residual disease or recurrence which is comparatively more common in canal wall up as compared to canal wall down surgery may lead to graft uptake failure. In contrast to the present study, Paparella et al., and Ragheb et al, [7, 11] reported no significant difference in graft take up rate in both the procedures.

Overall, no single method is suitable for every patient and cholesteatoma surgery should be individualised according to the patient's needs and the extent of the disease [12].

The decision between canal wall up (CWU) and canal wall down (CWD) mastoidectomy continues to balance hearing outcomes with disease control. Recent prospective studies affirm that CWU often leads to significantly better audiometric improvement — for instance, Samanta et al. reported superior mean hearing gain in CWU (12.6 dB) versus CWD (8.4 dB, p=0.0002) in squamosal CSOM [13]. Similarly, a randomized comparison by an Egyptian group demonstrated greater air–bone gap closure and lower AC thresholds post-CWU (P=0.025 and 0.039, respectively), albeit with a slightly higher but non-significant rate of disease recurrence [14]. These findings underscore the importance of surgical technique in functional recovery and suggest that, where appropriate, CWU may offer better hearing preservation.

In addition to hearing results, long-term outcomes and recurrence rates remain key determinants in selecting the surgical approach. A comparative modeling study indicated that CWU with planned second-look surgery often results in lower overall treatment burden, whereas

CWD provides a more definitive disease clearance in advanced cases [15]. Furthermore, recent systematic reviews highlight that CWD with mastoid obliteration achieves significantly lower recurrence rates compared to CWU (OR = 0.33, p<0.001) [16]. These data reinforce that surgical choice should integrate both audiological outcomes and long-term disease control, individualized to patient needs.

Conclusion

Hearing outcomes were better with canal wall up surgery as concluded by the present study. Though, canal wall down surgery is a safer option considering the residual disease and recurrence, but it causes a long-term dependence, hospital visits and comparatively significant difference in hearing outcomes. On the other side, Canal wall up surgery may need a second look procedure due to recurrence but provides better hearing outcomes. Therefore, there is a significant impact of the type of the surgical procedure on the functional hearing outcome.

Conflicts of interest

Authors declare no conflicts of interest.

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