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ORIGINAL ARTICLE

The Role of Grafting in Canal Wall down Mastoidectomy

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ABSTRACT

Background: Radical mastoidectomy is the outstanding standard technique for management of cholesteatoma. Long term studies showed increasing incidence of discharging cavities (1). Modified radical mastoidectomy was described to prevent recurrent cholesteatoma along with reconstruction of the ossicular hearing mechanismre. Exteriorization of the disease bearing areas is essential for effective follow up (2). However, there are many recesses which cannot be exteriorized regarding its anatomical location such as the mesotympanum. It will be a source of discharge or accumulation of keratin. Covering these recesses by grafting is an essential rather than optional step in all radical mastoidectomies to prevent problematic cavities.

Aim of work: Demonstrate the necessity of grafting in radical mastoidectomy for obtaining dry cavity.

Methods: A prospective, comparative study conducted from March 2016 to October 2019 on 60 cholesteatoma patients. Patients were randomized into 2 equal groups of 30 patients each. In group A, patients undergone modified radical mastoidectomy with grafting, while patients in group B have undergone radical mastoidectomy without grafting. Regular follow-up was done monthly for 1 year for both groups.

Results: In group A, 22 patients have intact grafts, and dry well epithelialized cavities, 2 patients had perforated grafts, 5 patients had small discharging granulations and 1 patient had a keratin pearl under the graft. In group B, 19 patients suffered persistent discharging cavity, 8 patients had less discharge with keratin debris and granulations and 3 patients had dry cavities.

Conclusions: Grafting is an essential step in radical mastoidectomy to prevent cavity problems.

INTRODUCTION

The classic radical mastoidectomy done for surgical management of cholesteatoma should entails removal of all ossicles except the stapes, removal of the tympanic membrane remnants without grafting and obliteration of the Eustachian tube orifice after eradication of the disease by removal and dissection of the cholesteatoma sac (3). For proper control of the disease after cortical mastoidectomy, the procedure is continued by removal of the bridge (the posterior bony wall) and then lowering the facial ridge to open the facial recess (the posterior buttress). Atticotomy is considered a corner stone step in radical mastoidectomy in which we remove the outer attic mass (the anterior buttress) to exteriorize the attic area. Basically, we look for four known hidden areas which are the most common sites of recurrence or residual disease and these areas are mainly the sinodural angle cells, anterior epitympanic recess, supratubal recess and mastoid tip (4).

Proper control of these areas requires drilling of bony overhangs and shelves to make shallow cavities with sloping saucerized edges. Finally, adequate meatoplasty is the last step of the

procedure and may be a key for success as it facilitates good postoperative visualization and care of the cavity. Modified Radical mastoidectomy has been described in 1910 by Bondy. Preservation of all or parts of ossicles, tympanic membrane grafting (leaving Eustachian tube patent) and ossiculoplasty are the main modifications. There are essentials which never to be omitted in both radical and modified radical mastoidectomies, proper access to the previously mentioned four hidden areas and adequate meatoplasty. However, the most critical modification is the tympanic membrane grafting to minimize cavity problems and manage hearing loss (5). After radical mastoidectomy, the obtained cavity consists of two different areas, the first is the bare bone of the mastoid bowel, and the second is the mucosa lined middle ear cleft. During the first six postoperative weeks, the squamous epithelium creeps in a centripetal direction from the meatus inward to cover the mastoid cavity, the tegmen mastoidium and facial ridge. Drilling and smoothening the mastoid cavity and exenteration of all cells will enhance and accelerate this process of epithelialization. In patients with classic radical mastoidectomy who have no grafts, the squamous epithelium will reach the middle ear and may behave in two different ways. The first and commonest way is what is called (Contact Inhibition of locomotion) figure (1) in which the creeping process is inhibited by the presence of middle ear respiratory epithelium which is a secretory lining and may be rich in Goblet glands due to long standing infection resulting in a discharging cavity (6). The second scenario in patients with atrophic fibrotic lining middle ear mucosa, the squamous epithelium will migrate to line the middle ear cleft with its all recesses and irregularities including the sinus tympani, round window niche, foot plate area, hypotympanic cells and supratubal recess figure (2). Nevertheless, if the stapes is intact or partially eroded, the skin will creep over and in between the crura depleting the hope for second stage ossiculoplasty. The skin lining these recesses will accumulate keratin debris on long run and may result in granulations, osteitis and recurrent cholesteatoma (8). A third scenario may exist which is a combination of the other two scenarios in which there is partial creeping of the squamous epithelium to line scattered areas of the middle ear (figure 3). In modified radical mastoidectomy, if we do grafting of the tympanic membrane remnants the squamous epithelium will continue creeping over the graft in continuity with the rest of the cavity (figure 4). Obliteration or covering all middle ear recesses will convert them to a shallow flat surface. If there is intraoperative missed skin or keratin debris in one of these hidden areas under the graft, middle ear cholesteatoma will result and manifest as a whitish pearl or sac behind the semitransparent graft.

PATIENTS AND METHODS

A prospective, comparative, randomized study conducted from March 2016 to October 2019 on 60 patients suffering chronic suppurative otitis media with cholesteatoma. Patients have been randomized into two equal groups of 30 patients each (groups A and B). The patients in group A have undergone modified radical mastoidectomy with tympanic membrane fascial grafting, while the patients in group B have undergone radical mastoidectomy without grafting. Regular follow-up visits were done monthly for at least 1 year for both groups.

ETHICAL CLEARANCE

The ethics committee of our institution approved this work according to the Declaration of Helsinki. A detailed informed consent was obtained from each patient.

METHODS

All patients were assessed based on a thorough history, otologic examination, and full audiological evaluation. High-resolution computed tomography scan of the temporal bone was performed for each patient to assess the middle ear cavity and mastoid pneumatization.

OPERATIVE TECHNIQUE

Under general hypotensive endotracheal anesthesia, 60 patients of both groups have undergone radical mastoidectomy via a post-auricular approach. The procedure involves raising a periosteal flap, exposing the spine of Henle to start drilling in the Mc Ewen's triangle, proceeding in the three main directions, the dural plate, the sinus plate and the line parallel to the posterior canal wall. After exenteration of diseased mastoid air cells and removal of granulations and cholesteatoma sac, identification of the antrum and lateral semicircular canal is established to proceed with canal wall down approach. Drilling and removal of the posterior bony wall (bridge removal) and lowering the facial ridge (the posterior buttress) to the level of lateral semicircular canal or the lower tympanic annulus is accomplished depending on the depth of mastoid tip and the extend of cholesteatoma. Then atticotomy is performed by drilling the outer attic mass or the entire superior bony wall (the anterior buttress) to exteriorize the attic region. The following step is drilling out bony overhangs and saucerizing the mastoid cavity to reach the tegmen tympani and mastoidium superiorly and the sinus

plate posteriorly. Adequate access and visualization of the hidden area was done which includes the anterior epitympanic recess, supratubal recess, sinodural angle cells and tip cells. Now we divide patients into two equal groups, 30 patients each group A and group B according to the following steps.

In group A, we have performed modified radical mastoidectomy by grafting the tympanic membrane remnants by temporalis fascia graft. Before grafting, we spent every effort to explore hidden middle ear recesses especially in patients with extensive cholesteatoma and to clear these areas from skin or debris particularly in patients with stapes or crura affection to avoid recurrence under the graft. In 12 patients, we utilized endoscopic assessment for better visualization but still we have no guarantee regarding disease free recesses. So we have used the temporalis fascia graft rather than cartilage graft to enable us to pick up early recurrence of cholesteatoma which will manifest as a whitish pearl or sac under the graft. We elevated the fibrous annulus anteriorly using a curved round knife for dissection in a medial to lateral direction. The grafting dimensions start from the facial ridge posteriorly to the anterior bony annulus anteriorly and from the tympanic facial canal superiorly to the annulus inferiorly. The graft was positioned under the tympanic membrane remnants and splinted by Gelfoam in the middle ear and the cavity. Special support of the graft anteriorly by more of a dry Gelfoam to keep it lateral to the Eustachian orifice was performed. In all grafted patients, there was an adequate middle ear space under the graft being raised mainly in its four borders, superiorly by the height of tympanic facial canal and cochleariform process, posteriorly by the height of facial ridge and by Gelfoam in its inferior and anterior borders. This space enabled us to perform different types of ossiculoplasty. In 15 patients (50%), we did myringostapedopexy putting the graft directly on the stapes head or crura remnants. In 7 patients (23.3%), we did incus interposition between the malleus and the stapes head after making socket in the side of the incus body to adapt the stapes head. In 6 patients (10%) with absent stapes superstructure, we utilized the head of malleus or the incus after shaping and smoothening to fill the gap (air bubble) between the graft and the foot plate. In 2 patients (6.6%) with profound sensorineural hearing loss or dead ears, we also put the graft for the aim of the study.

In group B (classic radical mastoidectomy), no grafting was done leaving the middle ear mucosa bare. However, in cases of edematous or polypoid middle ear mucosa or keratin debris in the middle ear recesses we performed partial removal by cotton curettage and various instruments.

Finally in both groups, we performed adequate meatoplasty in which we perform a posterosuperior full thickness cut in the external auditory meatus and canal skin. This cut reaches the anterior helical crus but without cutting it. We reclosed the periostium after shortening it to be under tension and keep the posterosuperior cut gaped. After skin closure by interrupted silk or vicryl sutures, we filled the cavity with dry Gelfoam and insinuate tight meatal pack formed of gauze soaked with antibiotic ointment for keeping the cut edges gaped adequately.

Postoperative follow up visits every week for the first month and then monthly for one year was done. The meatal pack was changed by a new one after two weeks, to be changed every week for further three weeks and to keep the skin cut gapped to heal by secondary intention and retain the meatus wide adequately.

STATISTICAL ANALYSIS

Data management and analysis were performed by using the statistical analysis systems. Numerical data have been summarized using means and SDs or mean and ranges and Fisher exact test with statistical significance at $p \leq 0.05$. Categorical data have been summarized as percentages. The $\chi 2$ test was used to compare between the groups concerning categorical data. All *P* values are two-sided. *P* values less than 0.05 were considered significant.

RESULTS

The average age of patients in group A was 29.0±3.5 years, whereas that in group B was 31.5±4.75 years. The study population comprised 27 male patients (45%) and 33 female patients (55%).

OPERATIVE RESULTS

In group A, the operative time ranged from 1.7 to 2.1 hours with a mean of 1.9 hours. Blood loss has a range of 124-185 ml with a mean of 160 ml. Hospitalization was 1 day in all patients of this group with discharge in the second postoperative day. As regards complications, there were no complications in the form of injury to adjacent critical structures including ossicles, dura, sinus and facial nerve. Return to regular normal life activity or work was possible in all patients after 14 days.

As regards to the final outcome, Figure 5 pie (1), all patients were subjected to periodic regular weekly assessment for the first month and then

monthly for one year. In group A, 22 patients (73.3%) were doing well throughout the follow up period with intact graft, ventilated middle ear and dry well epithelialized healthy cavity, 2 patients (6.6%) had perforated grafts, 5 patients (16.6%) had posterior superior small discharging granulation and 1 patient (3.3%) had a keratin pearl under the tympanic membrane. For the perforated grafts, we planned permeatal or endoscopic tragal perichondrial grafting. Regarding the five patients with discharging granulations, we have used frequent packing by an antibiotic steroid combination creams but there was recurrence, so we curetted these granulations by the suction tip with satisfactory results in three patients and we performed chemical cautery in the resistant patients with silver nitrates. For the patient with keratin pearl under the graft, we just incised over it by a sickle knife in the outpatient clinic and suctioned its contents safely. Pure tune audiometry revealed persistent conductive gap in 19 patients (63.3%), minimal gap closure in 7 patients (23.3%), mild increase in conductive gap in 2 patients (6.6%) and profound sensorineural hearing loss in 2 patients (6.6%) who were already having preoperative profound hearing loss.

In group B, the operative time ranged from 1.4 to 1.9 hours with a mean of 1.6 hours. Blood loss has a range of 115–138 ml with a mean of 122 ml. Hospitalization was 1 day in all patients of this group with discharge in the second postoperative day. As regards complications, there were no complications in the form of injury to adjacent critical structure mainly the facial nerve, the lateral canal and the posterior canal wall. As regards the final outcome, in group B, figure 6 pie (2), 19 patients (63.3%) suffered from persistent discharging cavity with raw area at the site of mesotympanum lined by mucosa and granulations, 8 (26.6%) patients had lesser discharge with keratin debris and granulations in various sites in the area of mesotympanum, and 3 (10%) patients had dry cavities albeit having keratin debris without granulations. For the wet discharging cavities 27 (19 +8), we performed repeated regular weekly packing by antibiotic steroid creams and ear drops but with ultimate recurrence after cessation of packing. We avoided chemical cautery for fear of sensorineural hearing loss as there is no middle ear protection by a graft and possible round window absorption. For the three patients accumulating keratin, we practiced regular periodic suction clearance every three months. Pure tune audiometry revealed persistent conductive gap in 25 patients (83.3%), minimal gap closure in 2 patients (6.6%) and increased conductive gap 3 patients (10%). Return to regular life activity or work was possible in all patients after 14 days.

Before matching results of both groups, patients are categorized into four main outcomes. The first category contains patients with excellent outcome in the form of silent dry well epithelialized cavity and this group is composed of 22 patients 73.3% from group A versus no patients 0% from group B. The second category consists of patients with moderately improved outcome having dry ear but with minimal pathology. This second category is composed of 3 patients 10% of group A (2 patients with residual dry perforation and one patient with a pearl under the graft) versus 3 patients 10% in group B having some keratin debris. The third category, those patients with slight improvement of the outcome suffering intermittent discharging cavity with granulations and is composed of 5 patients 16.6 % from group A versus 8 patients 26.6% from group B. The fourth categories of patients are those with no improvement who present with persistent discharging cavity. This group consists of no patients zero % from group A and 18 patients 63.3% from group B. Analysis of these results shows statistically significant difference between group A and group B in the first , third and fourth categories with P value $p \leq 0.05$. Whoever, in the second category there no statistically significant difference between Groups A and B with p value > 0.05. Table1.

Table 1: Statistically significant difference between group A and group B in the first, third and fourth categories with P value $p \leq 0.05$. Whoever in the second category there no statistically significant difference between Groups A and B with p value > 0.05.

Final Outcome				
Categories Groups	**Category 1** Excellent outcome (silent dry well epithelialized cavity)	**Category 2** Moderate improvement (dry ear but with minimal pathology)	**Category 3** Slight improvement (Intermittent discharging cavity with granulations)	**Category 4** No improvement (Persistent discharging cavity)
Group A	22 patients 73.3%	3 patients 10% (2 patients with residual dry perforation and one patient with a pearl under the graft)	5 patients 16.6 %	No patients zero %
Group B	No patients 0%	3 patients 10% (some keratin debris)	8 patients 26.6%	18 patients 63.3
Statistical Significance and p value	Statistically significant difference with P value p≤0.05	Not statistically significant Difference with p value > 0.05	Statistically significant difference with P value p≤0.05	Statistically significant difference with P value p≤0.05

Figure 1: Blue lining represents the squamous epithelium lining the mastoid cavity and external canal with arrest of migration due to CIL at the borders of the middle ear due to its mucosal lining in the form of rose line.

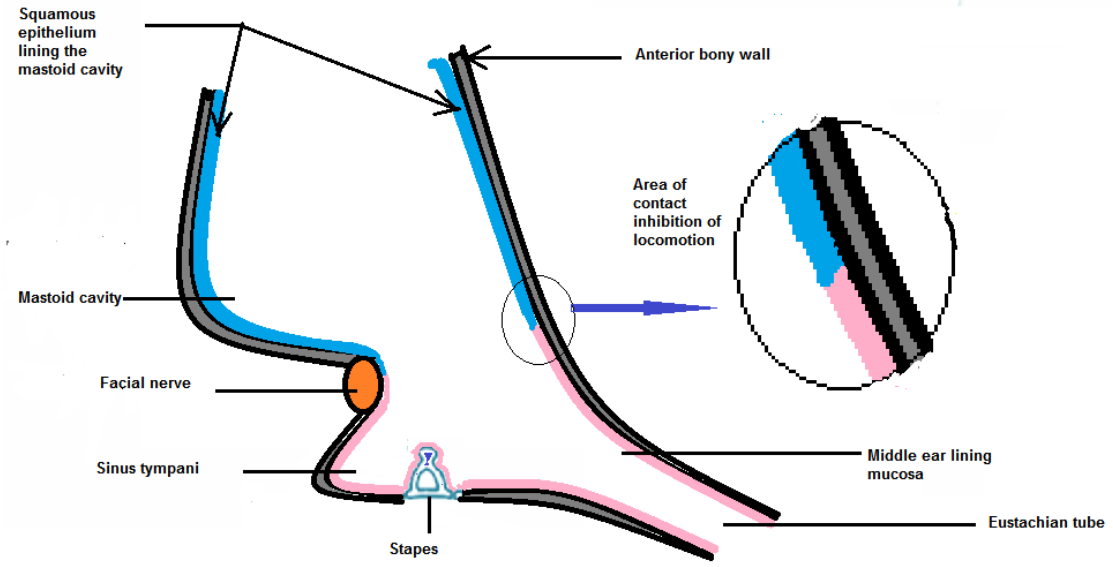


Figure 2: Blue lining represents the squamous epithelium lining the mastoid cavity and external canal which migrated and lined the middle ear cavity and recesses but arrested to migrate at the Eustachian tube orifice due to CIL from the mucosal lining in the form of rose line.

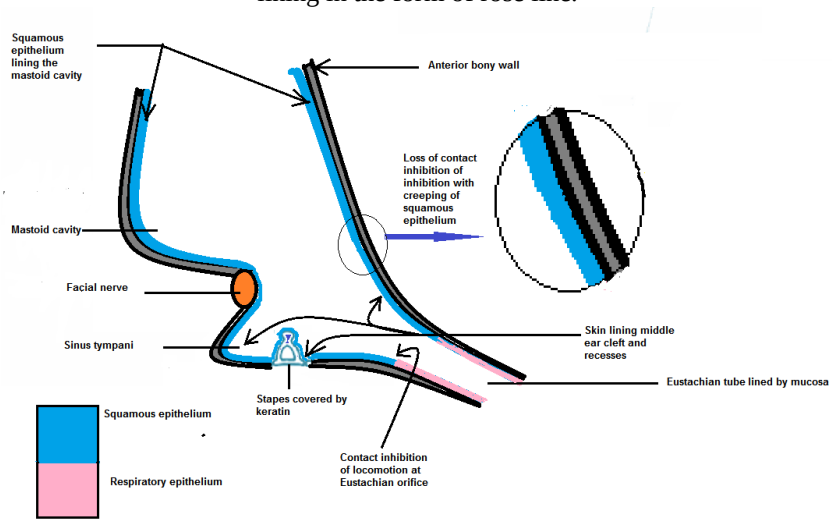


Figure 3: Blue lining represents the squamous epithelium lining the mastoid cavity and external canal which migrated partially and lined islands of the middle ear cavity and recesses but arrested to migrate at the Eustachian tube orifice due to CIL from the mucosal lining in the form of rose line.

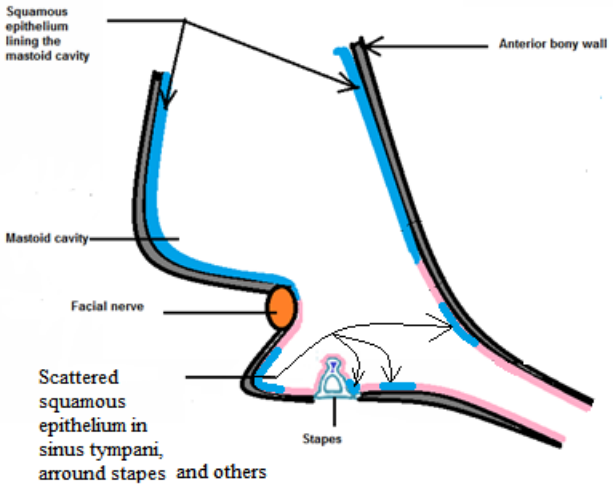
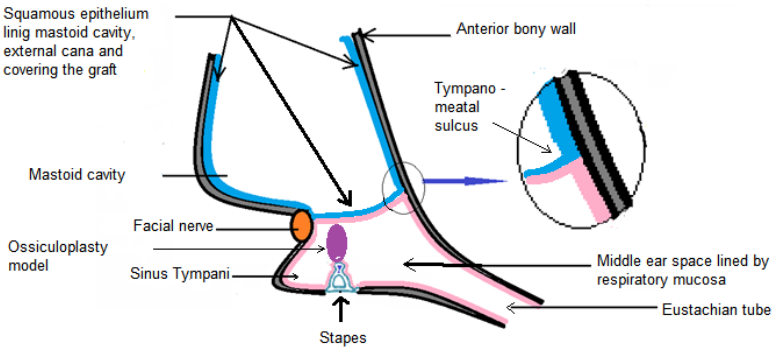
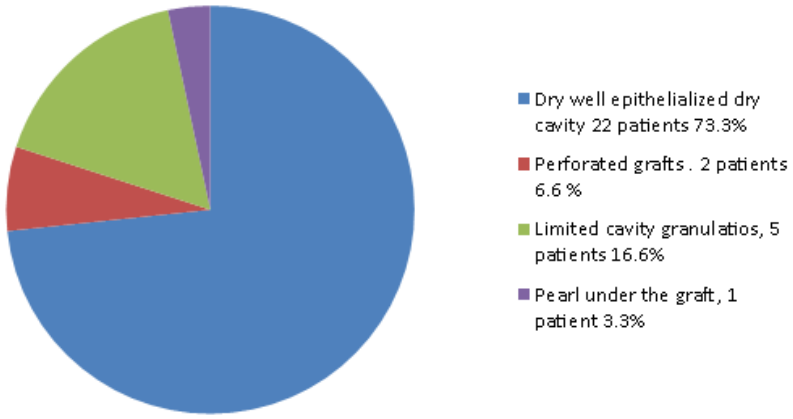


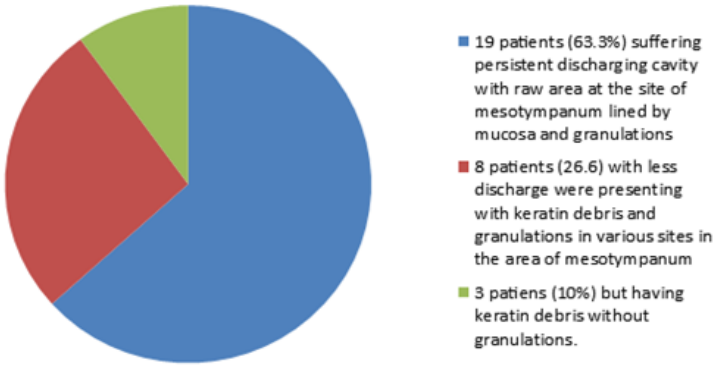
Figure 4: Blue lining represents the squamous epithelium lining the mastoid cavity, external canal and covering the graft with isolated middle ear space lined by respiratory epithelium. (in Group A)



Figure; 5 Pie 1. Group A , the grafted group



Figure; 6 Pie 2, Group B, the non grafted group



DISCUSSION

Radical cavity problems along many decades have stimulated huge number of research works and different procedures to solve and prevent its occurrence. These procedures are classified into three main categories or approaches, mastoid obliteration surgeries, canal wall up mastoidectomy and modified radical mastoidectomy. Mastoid obliteration procedures have utilized many different materials and techniques with highly variable success rates (9,10). Hyper dry amniotic membrane (11, 12), myoperiosteal and rotation cutaneous flaps and pedicles, bone pate and cartilage (13,14) are few examples of these maneuvers.

For successful obliteration, without complications or recurrence there should be high confidence of disease clearance all over the area to be obliterated to avoid late presentation of unwanted recurrence and possible complications. Definitive eradication of cholesteatoma from the mastoid air cells may be challenging in some situations like congenital cholesteatoma with its characteristic skip or satellite lesions (15). Nevertheless, this situation may happen in some recurrent cholesteatomas where the pathology may consist of multiple sacs. Obliteration of the mastoid will definitely lead to late advanced and even complicated recurrences (16).

Regarding canal wall up mastoidectomy, it is viable alternative in selected situations for which specific procedures and techniques are adapted to manage localized cholesteatomas like posterior tympanotomy for limited facial recess lesions and endoscopic procedures to control sinus tympani cholesteatoma or limited attic involvement, etc. (17). However, still the standard outstanding surgical management for various types of cholesteatomas is modified radical mastoidectomy. Modified radical mastoidectomy has been described in 1910 by Bondy in which we obtain common cavity formed of the mastoid bowl, attic and the external auditory canal. This cavity is lined by skin which covers also the new tympanic membrane or graft isolating a middle ear space. This procedure is mainly done to get

dry silent or healthy cavity and functioning sound conduction system (18).

In our study, we are aiming to focus on the pivotal role of grafting and its necessity in all radical mastoidectomies and discussing a cost benefit relationship augmenting our study. As mentioned above, the squamous stratified epithelium lining the auditory meatus and external canal will start a migration process throughout the postoperative weeks to line the cavity. However, without grafting this migration will stop and the epithelialization will be arrested by a process known as contact inhibition of locomotion (CIL). CIL phenomenon is one of several cell phenomena controlling cell movement and direction in the process of wound healing and migration of cells in malignancy (19). CIL occurs when migrating or creeping cells encounter another type of lining cells, figure (1). Therefore, during the healing process the squamous epithelium creeping will stop at the periphery of the middle ear being in contact with its lining by respiratory mucosa. Also this epithelialization will stop around any mastoid air cell which has not been drilled well leaving its lining mucosa (20).

As a result, the postoperative cavity will be lined partially by skin over bare bone and partially by respiratory mucosa lining the middle ear wall and recesses and also covering any mastoid air cell missed from proper drilling. Respiratory mucosal lining has secretory function leading to wet discharging cavity especially with infection which will increase the number of Goblet cells in the lining mucosa and increase discharge. In rare situations, another scenario may occur in which there no Contact Inhibition of Locomotion is leaving the squamous epithelium to continue creeping and to line the middle ear cleft and all its recesses, figure (2). This may happen due to atrophic fibrotic middle ear mucosa due to prolonged infection and loss of the CIL phenomena. In this second scenario the lining skin well accumulate keratin debris in the middle ear and its recesses due to inability of self-cleaning, resulting in repeated infection, osteitis and granulations with the end result of discharging cavity again.

On the other hand, covering the middle ear mucosa by temporalis fascia graft will prevent the process of CIL as the graft is formed of fibrous tissue having no any lining cells. In addition, this graft will prevent the second possible scenario in which the skin invades and line the middle ear recesses. In a category of patients with extensive disease where there is squamous epithelium covering middle ear structures such as stapes or its crura or lining middle ear recesses such as the sinus tympani, round window niche, foot plate or hypotympanic air cells, we recommend spending every effort and time to clear all skin remnants utilizing high power microscopic magnification, special fine instruments and endoscopic assessment to reach hidden areas. Following this, we recommend applying a thin temporalis fascia graft to cover the middle ear mucosa isolating a middle ear space as a functioning sound conduction system. The graft should be thin fascia rather than thick or opaque cartilage graft to reflect any possible underling residual cholesteatoma as a whitish pearl or sac throughout the follow up period. From the cost benefit relationship point of view, spending exhausting efforts to clear middle ear recesses from skin debris before grafting outweigh the simple fast radical mastoidectomy without grafting but with a definite sequel of discharging cavity (in our study 63.3% +26.6% = about 90%).

This is true even with possible recurrence or residual disease under the graft which in our study was present in one patient 3.3% and could be managed easily in the outpatient clinic or in the operative theater. Apart from considering sound conduction system management, dry healthy ear is considered a priority above hearing loss management. That was the rational for grafting two patients in group A having profound hearing loss in the operated ear. In modified radical mastoidectomy, some authors perform partial grafting in the form of round window protection (21) by applying graft to cover the round window niche just only to improve hearing in a process known as phase difference or buffer effect. Whoever, again with this modification some middle ear recesses and irregularities are still exposed such as sinus tympani, foot plate

area and supratubal recess. So, these recesses will also present troubles either with squamous cell epithelialization or without Figures (1, 2 and 3).

In all patients of both groups and before grafting in group A, we have followed strict compulsory steps to exactly fulfill the ideal criteria of intraoperative standard cavity and to fix variables in both groups. These steps are enumerated as follows:

1- Exenteration of all mastoid air cells and smoothening bone to be sure of absent mucosal lining of any air cell which may lead to contact inhibition of locomotion and scattered areas of raw discharging non epithelialized foci.
2- Removal of the bridge or the posterior canal wall (posterior canal wall down).
3- Special attention to particular areas, sinodural angle air cells, retrofacial air cells, mastoid tip cells, supratubal recess and anterior epitympanic recess.
4- Adequate lowering of the facial ridge or the posterior buttress to the level of the lateral semicircular canal or the inferior bony annulus according to the depth of mastoid tip and the extend of the disease.
5- Proper atticotomy by removal of the outer attic mass or the superior canal wall (superior canal wall down) or the anterior buttress to be flush with the tegmen tympani.
6- Looking for the distance between the anterosuperior anterior buttress and the posteroinferior posterior buttress to be wide and adequate. Narrow distance is considered a very common etiology of narrow problematic cavity.
7- Finally, we performed wide but cosmetic meatoplasty keeping its cut ends of the skin gaped for 4-6 weeks by regular weekly pack changing and to promote healing by secondary intention.

Limitation of the study:

We have found limitations of this study to be mainly the few number of patients and relatively short period of the study. So we recommend conducting this work on a larger scale including more patients along **longer duration**

Conclusion:

We found that fascial grafting is an essential rather than optional step in modified radical mastoidectomy to get healthy dry cavity. Temporalis fascia grafting may be the most important and easy measure to prevent cavity problems.

Ethics approval and consent to participate :

Local ethics committee approved,no nomber available ,the consent obtained from our Ear, Nose and Throat department, Hearing and Speech institute, General Organization for Teaching Hospitals and Institutes, Egypt.

the study not expirmental nor clinical trial.

Consent for publication :

Written Consent for study publication was obtained from all study participants.

Availability of data and materials :

The datasets used and/or analyzed in the current study are available from the corresponding author on reasonable request.

Competing interests:

The authors declare that they have no competing interests

Funding :

None

Authors' contributions:

All operations were done by EF and WE and observed by both. EF and WE shared in the data collection and interpretation of the results. EF was main contributors in writing the manuscript. both authors finally read and approved the final manuscript.

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REFERENCES

1. Khalil HS, Windle-Taylor PC. Canal wall down mastoidectomy: a long term commitment to the outpatients? BMC Ear Nose Throat Disord 2003; 3:1.
2. Youngs R. The histopathology of mastoidectomy cavities, with particular reference to persistent disease leading to chronic otorrhoea. Clin Otolaryngol 1992;17:505–10.
3. Henatsch D, Alsulami S, Duijvestijn AM, Cleutjens JP, Peutz-Kootstra CJ, Stokroos RJ. Histopathological and inflammatory features of chronically discharging open mastoid cavities: secondary analysis of a randomized clinical trial. JAMA Otolaryngol Head Neck Surg 2018; 144:211–17.

4. Mills R. Surgical management of the discharging mastoid cavity. J Laryngol Otol Suppl 1988;16:1–6.
5. Binti Abdullah A, Hashim SM, Muhammad Almyzan Awang, B.Aud (Hons), Lokman Saim. Outcome of canal wall down mastoidectomy: experience in sixty three cases. Med J Malays 2013; 68(3):217–21
6. Ridley A.J. Cell migration: integrating signals from front to back. *Science.* 2003;**302**:1704–9.
7. Roberto Mayor and Carlos Carmona-Fontaine, Social behaviour of migratory cellsTrends Cell Biol. 2010 Jun; 20(6-3): 319–28.
8. Garap JP, Dubey SP. Canal-down mastoidectomy: experience in 81 cases. Otol Neurotol 2001;22:451–56.
9. Ojala K, Sorri M, Sipila P, Palva A. Late changes in ear canal volumes after mastoid obliteration. Arch Otolaryngol 1982;108:208–9.
10. Harun A, Clark J, Semenov YR, Francis HW. The role of obliteration in the achievement of a dry mastoid bowl. Otol Neurotol 2015;36:1510–1517.
11. Yuji Kanazawa[1], Hideo Shojaku, Motonori Okabe, Michiro Fujisaka, Hiromasa Takakura, Hirohiko Tachino, et al. Application of hyperdry amniotic membrane patches without fibrin glue over the bony surface of mastoid cavities in canal wall down tympanoplasty. Acta Otolaryngol 2012;132:1282–87.
12. Sugar M. The use of amnioplastin in the surgery of the ear. J Laryngol Otol 1944;59:96–100.
13. Mokbel KM, Khafagy YW. Single flap with three pedicles, bone paté and split-thickness skin graft for immediate mastoid obliteration after canal wall down mastoidectomy. Eur Arch Otorhinolaryngol 2012;269:2037–41.
14. 13. Kanemaru S-I, Hiraumi H, Omori K, Takahashi H, Ito J. An early mastoid cavity epithelialization technique using a postauricular pedicle periosteal flap for canal wall-down tympanomastoidectomy. Acta Otolaryngol Suppl 2010; 130:20–3.
15. Nelson M, Roger J, Kotlai PJ, Garabedian EN, Triglia JM, Roman S et al. Congenital cholesteatoma: classification, management and outcome. Arch Otolaryngol Head Neck Surg 2002; 128(1):810–814
16. Ojala K, Sorri M, Sipila P, Palva A. Late changes in ear canal volumes after mastoid obliteration. Arch Otolaryngol 1982;108:208–9.
17. Quaranta N, Iannuzzi L, Petrone P, D'Elia A, Quaranta A. Quality of life after cholesteatoma surgery: intact–canal wall tympanoplasty versus canal wall–down tympanoplasty with mastoid obliteration. Ann Otol Rhinol Laryngol 2014;123:89–93..
18. Jose Acuin. Chronic suppurative otitis media. Burden of illness and management options. World Health Organization 2004; Geneva.
19. Petrie R.J. Random versus directionally persistent cell migration. *Nat. Rev. Mol. Cell Biol.* 2009;**10**:538–49.
20. Takai Y. Nectins and nectin-like molecules: roles in contact inhibition of cell movement and proliferation. *Nat. Rev. Mol. Cell Biol.* 2008;**9**:603–15.
21. P Montandon, and C Chatelain, Restoration of hearing with type V tympanoplasty, ORL J Otorhinolaryngol Relat Spec. 1991;53(6):342-5.

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