Does preoperative bacterial culture have bearing on healing of mastoid cavity: A prospective study*

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A B S T R A C T

Objective: To study the bacteriological profile in a healing mastoid cavity.
Methods: This study was a single centre prospective study. Culture swabs from granulations in the mastoid cavity were sent in 40 consecutive patients with squamosal chronic otitis media undergoing mastoidectomy. Cultures were processed for both aerobic and anaerobic bacteria.
Results: Preoperatively: specimens from 26 out of 40 (60.5%) had growth on culture, with 22 (55%) showing only one organism while 4 showing multiple organisms. The commonest organism isolated was pseudomonas aeruginosa (n = 15).
At 1 month after mastoidectomy, 11 patients had sterile culture while 29 had growth, of which 26 had aerobic growth and 3 had anaerobic growth. Pseudomonas was seen in 22 patients and staphylococcus aureus in 2 patients. The mean Merchant score was 2.
At 3 months: 29 patients (72.5%) had sterile culture from mastoid cavity while 11 patients (27.5%) had growth on culture. All positive cultures were aerobic, including pseudomonas (n = 9) and proteus (n = 2).
The mean Merchant score was 1.03. Of the 40 patients, 16 (40%) had a different organism cultured postoperatively compared to preoperative swabs.
Conclusion: Pseudomonas and proteus seem to be the most common organisms responsible for persistent otorrhea after mastoidectomy. Persistent sterile otorrhea was seen in 4 patients (10%) in this group at the end of 3 months. Sterile cultures of preoperative swab are more likely to remain sterile in the postoperative period.

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1. Introduction

Surgery for chronic suppurative otitis media has always been challenging. New techniques and operative methods have evolved over the years to achieve permanent and satisfactory end results after ear surgery. A chronically discharging open mastoid cavity can be very frustrating for patients and can render patients to be more symptomatic than the primary condition for which surgery was done (Nadol, 1985). A discharging open mastoid cavity continues to discharge because of three main reasons (Guilford, 1960; Al Mayaly et al., 2007), i.e. residual diseases left in the cavity, unfavourable shape and size of the mastoid cavity like high facial ridge, large cavity and narrow meatoplasty, and biological microorganisms inhabiting the mastoid cavity.

Bacteriological examination of a healing mastoid cavity was considered nonessential in the past because it was thought that even if the cavity became infected, it was self-draining and would not impair the healing of the mastoid cavity (Palva and Hallstrom, 1965). With advent of newer generation of antibiotics, considerable importance has been attached to bacteriology of a post-operative mastoid cavity (Yeo et al., 2007). According to Kim et al., bacteriological analysis of post-operative otorrhea is important,
and failure to appropriately treat post-operative otorrhea prevents the cure of chronic otitis media (Kim et al., 2017). Persistent infection in the mastoid cavity hampers healing and is the leading cause of persistent otterrhea (Yeo et al., 2007).

This study was undertaken to analyse impact of microbiological profiles in the healing of an open mastoid cavity.

2. Material and methods

This study was a single centre prospective study. We included 40 consecutive cases of active/inactive squamous chronic otitis media from Jan 2016 to June 2017. The study was approved by the institutional ethics committee. Active squamous otitis media in our study was defined as presence of cholesteatoma with retraction of pars tensa/flaccida and retained squamous epithelium, debris and purulent discharge, while inactive (squamous) otitis media was retracted pars tensa/flaccida usually in the postero-superior quadrant with retained debris but no active purulent discharge although with the potential of becoming active at a later date.

Patients younger than 10 yrs or older than 60 yrs, immune compromised, with a history of antibiotic usage within 7 days before surgery, or demonstrating complications of chronic mastoiditis were excluded from the study. All the patients underwent a detailed otolaryngological and microscopic examination, along with pure tone audiometry. A high resolution computed tomography scan was done in all the patients. Plans of surgery were discussed with patients in our otology clinic.

All patients underwent surgery under general/local anaesthesia by a single senior surgeon. Preoperative swab for bacterial culture was done in the operation theatre under a microscope following strict asepsis. Canal wall down mastoidectomy with or without ossicular reconstruction was done through a standard post auricular approach. Gel foam soaked with polymyxin B sulphate, neomycin sulphate and hydrocortisone was kept in the mastoid cavity. Postoperative prophylactic systemic antibiotics were not given in any patients.

All patients were followed up on postoperative day 1 and weeks 4, 8 and 12.

Examination on day 1 was focused on wound site hematoma. At weeks 4, 8 and 12, oto-endoscopy was done by independent observers and mastoid cavity condition was assessed using the adapted Merchant score (Merchant et al., 1997).

Bacteriological swabs from mastoid cavity were sent for culture. Pure tone audiometry was done at week 12 to assess hearing improvement.

Statistical analysis: all parametric data were subjected to normality test (Kolmogorov Smirnov test) for distribution assessment. Data with normal distribution were compared using paired T test, while skewed data were tested for significance with Mann Whitney U test. All categorical and classified data were tested with chi square test.

2.1. Adapted Merchant score

0 No complaints, no pus or granulation tissue on examination
1 No otorrhea but subjective feeling of wetness of ear
2 Otorrhea and oto-endoscopic examination showing pus
3 Localized granulation tissue
4 Extensive granulation tissue

3. Results

A total of 40 patients with attico-antral type of chronic otitis media who fulfilled inclusion and exclusion criteria were enrolled in the study, including 22 males and 18 females with a mean age of 23.85 (10–55) years.

Of the 40 patients, 26 (65%) had a positive growth on preoperative aural swab culture, while swab in 14 (35%) was sterile. Culture showed aerobic growth in 22 patients, anaerobic growth in 15 patients and both aerobic and anaerobic growth in 3 patients (Fig. 1). Single bacterial strain infection was seen in 22 patients while multiple organisms were cultured from preoperative aural swab in 4 patients. The commonest organism isolated was pseudomonas aeruginosa (15/40, 37.5%) (Table 1). Proteus was present in 4 patients, klebsiella in 2 patients, escherichia coli in 2 patients and staphylococcus aureus in 2 patients. One patient had growth of leuconostoc mesenteroides (Table 1).

Adapted mean Merchant score of the healing of mastoid cavity during follow up was determined by independent observers using 0 and 30 endoscopes. Mean Merchant score was 1.3 (1–4) at day 8, 2.3 (1–4) at 4 weeks, 1.8 (1–4) at 2 months and 1.04 (0–3) at 3 months. The mastoid cavity was dry in 25 (62.5%) patients at the end of 3 months with a Merchant score of 0, although the cavity had persistent granulations with discharge in 15 patients (37.5%) with a Mean merchant score of 2.1.

Postoperative culture swab on day 8 showed sterile culture in 14 patients (35%) but growth on culture in 26 patients (65%), including aerobic growth in 19 patients and both aerobic and anaerobic growth in 6 patients. When compared with preoperative culture, we found that out of the 14 patients showing sterile culture, 8 remained sterile while 6 developed new infection; whereas among the 26 patients with preoperative bacterial growth, 6 became sterile while 20 continued to have growth. The mean Merchant score for those with sterile culture was 1.5 (0–2) and 1.8 (0–3) for those with positive culture (P > 0.05) (Figs. 2 and 3) (Table 2).

Postoperative culture results at 1 month showed growth in 29 patients (72.5%), of whom 26 had aerobic growth and 3 had both aerobic and anaerobic growth. Of the 14 patients with sterile culture on day 8, 8 continued to show sterile culture while 6 developed infection. Among the 26 patients who had growth on day 8, 3 became sterile while 23 continued to have growth on culture. The mean Merchant score for patients with sterile culture was 1.4 (0–3) and 2.1 (0–4) for those with positive culture (Fig. 4).

Postoperative culture results at 2 month showed that 17 patients had sterile culture from the mastoid cavity while 23 patients had positive growth on culture, of whom 22 had aerobic growth while 1 had both aerobic and anaerobic growth. Of the 11 patients with sterile culture at 1 month, 10 continued to show sterile culture while 1 developed new growth. Out of the 29 patients showing bacterial growth at 1 month, 7 became sterile while 22 continued to show growth. The mean adapted Merchant score at 2 months was 1.2 (0–2) for those with sterile culture and 2 (1–4) for those with positive culture (P < 0.05).

Postoperative culture from mastoid cavity at 3 months showed sterile culture in 29 patients and bacterial growth in 11 patients (all aerobic), including pseudomonas (n = 9) and proteus (n = 2). All 17 patients with sterile culture at 2 months continued to show sterile culture while in 12 of the 23 patients who showed growth at 2 months became sterile with the remaining 11 continued to show growth. Mean Merchant score for those with sterile culture was 1.2 (0–4) and 2.1 (1–4) for ears with positive culture (P < 0.05).

At 3 months, 25 patients had dry cavity (i.e. adapted Merchant score = 0). The mean Merchant score was 2.1 (1–4) in the
remaining 15 patients, of whom 11 showed persistent growth from the mastoid cavity while 4 showed persistent sterile otorrhea (Fig. 4).

Interesting findings were noticed when we compared preoperative with 3 months postoperative aural swab culture results. Of the 26 patients showing positive growth preoperatively, 6 showed same organisms, 4 had different organisms, while culture in 16 became sterile. Whereas among the 14 patients showing sterile culture preoperatively, 13 remained so while 1 showed growth on culture (Tables 2 and 3).

### 4. Discussion

The goal of an otologist in canal wall down mastoidectomy is to achieve a continuous sheet of healthy keratinised squamous epithelium in a postoperative mastoid cavity. Changes in mastoid cavity that occur during healing include deposition of fibrous tissue, formation of adhesions and neo-osteogenesis (Friedmann, 1956). In an infected mastoid cavity, suppuration occurs which increases bone resorption, prevents new bone formation and delays epithelialisation of the mastoid cavity. Incomplete epithelialisation and recurrent contamination of the cavity result in persistent otorrhea.

In our study, we analysed microbiological results of granulations filling the mastoid cavity at various stages of healing with comparison to preoperative results. Preoperative aural swab showed positive growth in 26 (65%) patients, while 14 had sterile culture. The rate of positive growth was slightly higher than before surgery at 1 month (72.5%) but...
steadily decreased afterwards to only 27.5% at 3 months (Fig. 4). Kim et al. (2017) in their study reported bacterial growth in 45.5% of preoperative cultures, 13.5% of perioperative cultures and 4.5% of postoperative cultures. Slight increase in positive culture at 1 month after surgery was also seen in studies by Mishra et al. (1990). We attribute this to antibiotic soaked ear wicks placed to maintain patency of meatoplasty.

In our study, we also found mono bacterial growth in most (55%) cultures, with Pseudomonas aeruginosa (37.5%), Proteus (15%) and anaerobes (10%) being the most common organisms cultured from the healing mastoid cavity. Albert et al. (2005) in their study reported monobacterial growth in 37.5% and polymicrobial growth in 20% of cultures. In their study, coagulase negative Staphylococcus aureus was the most common organism followed by Pseudomonas aeruginosa. In our study, the incidence of Staphylococcus aureus growth (5%) was noticeably lower, which is slightly unusual.

Adapted Merchant scores reflecting status of the mastoid cavity appeared to be correlated with culture results, with a higher score seen at 1 month (2.3) indicating more inflammation in mastoid cavity when more patients showed positive culture, while a lower score (0.7) was seen after 3 months of surgery when greater number of patients showed sterile culture.

When comparing organisms cultured before and 3 months after surgery, we found that the same organism was cultured postoperatively in 6 patients (15%), as compared to 4 patients (10%) who had different organisms. The change in the bacteriology may be attributed to new infections occurring postoperatively, either through external auditory canal or Eustachian tube. Carlin et al. (1987) in their study also noted the occurrence of new organisms postoperatively. They studied their outcomes as either a favourable or an unfavourable change in bacteriology. A change from a pathogen to a commensal or sterile culture was taken as a favourable change. A change to pathogen or persistence of the preoperative pathogen was considered as an unfavourable change. We observed favourable changes in 15 patients and unfavourable changes in 11 patients. We also found that preoperative sterile culture was more likely to remain sterile during the postoperative period and more closely associated with healed and dry cavity. So we conclude that preoperative infected ear is more likely to give rise to persistently discharging cavity postoperatively.

Anaerobic infection was present in preoperative aural swab in 4 patients (10%). We noted an increase of anaerobic growth on day 8 after surgery which did not persist beyond 2nd months. We had very low incidence of anaerobic infection as compared to other studies. Higher incidence of anaerobic growth is reported more from mastoid with cholesteatoma disease. The low incidence...
reported in our study could be a result of culture being taken from the mastoid granulations in healing mastoid cavities which do not harbour anaerobic growth.

5. Conclusion

We conclude from our study.

1. Mastoid granulations seen during healing of mastoid cavity are not sterile and may harbour bacterial infection which may hamper healing of the cavity.

2. A sterile preoperative culture swab result is predictive of better healing of mastoid cavity and is more likely to remain sterile in the postoperative period.

3. Both favourable and unfavourable changes may occur during healing of mastoid cavity. Favourable change is more likely to lead to a dry ear.

4. Mean adapted Merchant score is indicative of inflammation in mastoid cavity and a high score more likely indicates existence of bacterial growth and less likely to forecasts dry ear without antibiotic coverage.

Table 2
Showing comparison of culture results between preoperative aural swab and Postoperative aural swab at day 8 and at 3 months.

| Preoperative cultured organism | Postoperative Day 8 | No of patients | Postoperative (3 months) | No of patients |
|--------------------------------|---------------------|----------------|--------------------------|---------------|
|                                | same                | 16             | same                     | 6             |
|                                | different           | 4              | different                | 4             |
|                                | fungus              | 0              | fungus                   | 0             |
|                                | no growth           | 6              | no growth                | 16            |
|                                | bacteria            | 5              | bacteria                 | 1             |
|                                | fungus              | 1              | fungus                   | 0             |
|                                | no growth           | 8              | no growth                | 13            |

5. The mastoid cavity is likely to become more infected 1 month after surgery, although it may still become dry as healing occurs.

Conflicts of interest and financial disclosure

There is no conflict of interest or financial disclosure to be made.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.joto.2018.03.001.

Table 3

| Cultures     | Sterile | Non-sterile | Manuka honey group (group 1) |
|--------------|---------|-------------|-----------------------------|
| Preoperative | sterile  | 35%         |                             |
|              | non-sterile | 69%   |                             |
| 1st month    | sterile  | 27.5%       |                             |
|              | non-sterile | 72.5% |                             |
| 2nd month    | sterile  | 42.5%       |                             |
|              | non-sterile | 57.5% |                             |
| 3rd month    | sterile  | 72.5%       |                             |
|              | non-sterile | 27.5% |                             |

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