Main Article

Microbial Spectrum and Antibiotic Resistance Patterns in Chronic Otitis Media: A Cross-Sectional Study with Emphasis on Atypical Organisms

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ABSTRACT

Introduction

Chronic Otitis Media (COM) is a persistent inflammatory condition of the middle ear with a high global prevalence, particularly in developing countries. The emergence of drug-resistant and atypical pathogens underscores the need for regular microbiological surveillance. This study is aimed to determine the microbial profile in active COM, focusing on atypical organisms and their antibiotic susceptibility.

Materials and Methods

A prospective cross-sectional study was conducted at a tertiary care hospital in Kolkata from February 2021 to August 2022. A total of 150 clinically suspected patients with active COM were enrolled. Aural discharge samples were cultured and analyzed for antibiotic sensitivity using Kirby-Bauer disc diffusion and the VITEK system.

Results

Of the patients, 63% were female and 84% had positive cultures. The right ear was more often affected (55%), with mucosal COM being more common (83%). Gram-negative bacteria (63%) predominated, mainly Pseudomonas aeruginosa (30%), Staphylococcus aureus (22%), and Klebsiella pneumoniae (9.3%). Pseudomonas showed fluoroquinolone sensitivity, while Staphylococcus and Klebsiella showed resistance. Rare pathogens included Stenotrophomonas maltophilia, Proteus hauseri, and Alcaligenes faecalis.

Conclusion

Chronic Otitis Media shows a female preponderance, with Pseudomonas aeruginosa and Staphylococcus aureus as the most commonly isolated pathogens. The emergence of atypical and drug-resistant organisms underscores the need for culture-guided therapy and regular antibiogram surveillance. Patients should be encouraged to adhere to the full course of prescribed antibiotics to minimize resistance and improve outcomes.

Keywords

Chronic Otitis Media; Atypical Pathogens; Antibiotic Resistance; Microbial Spectrum; Culture Sensitivity

Chronic infection of the middle ear cleft for at least 2 weeks or more is known as chronic otitis media (COM). COM can be of mucosal and squamosal varieties in active and inactive stages. COM can even be in healing stages manifesting as dimeric tympanic membrane, tympanosclerosis and fibro-osseous and fibro-cystic sclerosis.[1]

It is more prevalent in developing countries due to various predisposing factors such as malnutrition, overcrowding, poor hygiene, inadequate health care, and recurrent upper respiratory tract infection. Due to advancement in medical facility, India still falls under high prevalence zone. In India, the average prevalence of COM is 7.8%.[2]

COM can be due to repeated infections and usually manifests as a complication of acute otitis media. It can also be a result of eustachian tube defect and GERD.

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It is the common cause of conductive deafness which may lead to delayed development of speech and language in children.

All the cases of COM should be evaluated by examination of ear under microscope, audiological investigations, vestibular assessment and radiological imaging (HRCT Temporal bone/ X-Ray B/L Mastoid in Lateral-Oblique view) followed by otoendoscopic evaluation and culture/sensitivity of the pus/ discharge (in a case of COM in active stages).

The microbial profile and antibiotic sensitivity patterns in cases of chronic otitis media (COM) are crucial for effective treatment planning. The indiscriminate use of antibiotics has led to the emergence of drug-resistant strains, complicating therapeutic approaches.

While surgery is the definitive treatment for COM, early medical intervention with proper antibiotics based on common pathogens and their sensitivities is vital during active disease stages.

This study aims to identify aerobic, anaerobic, and atypical (i.e., rare microorganisms found in the cultures) microorganisms associated with COM and explore differences in microbial profiles between mucosal and squamosal varieties during active stages.

Materials and Methods

This single centre, hospital based prospective and cross-sectional study was conducted at Department of Otorhinolaryngology with collaboration of Department of Microbiology, in a tertiary care hospital, Kolkata between February 2021 to August 2022.

The sample size was calculated using the formula:

where Z = 1.96 (for 95% confidence), p = 0.078

$$n = {Z^2\ pq}/{e^2}$$

(prevalence of CSOM 7.8%, based on previous studies), q = 1 – p, and e = 0.05 (precision). Based on this, a minimum sample size of 150 was determined.

Thus, 150 clinically suspected patients of any age group & of both the sexes with history of repeated ear discharge (Unilateral or Bilateral) for more than 3 months, clinically diagnosed as cases of COM in active stages, were considered for *inclusion*.

Patients with ear discharge of acute onset (<2 weeks duration), patients with draining ears but intact tympanic membrane (otitis externa), patients with history of taking antibiotic either systemic or local in the form of ear drops for last 7 days, patients who refuse to consent to participate in the study and patients with COM with co-morbidities like neoplastic conditions of ear were *excluded* from the study.

Ear discharge was aspirated with a sterile pipette under aseptic precautions in clinically diagnosed cases of COM and immediately sent to the laboratory for microbiological analysis, i.e., culture and antibiotic susceptibility testing [using Kirby-Bauer disc diffusion method/ VITEK (automated system)].

After ear swabs were taken, wet mopping was done to clean the external auditory canal and clinically classify the ear as a mucosal or squamous variety of COM. Data were compiled and analyzed using IBM SPSS Statistics software (version 29), with Microsoft Excel used for data tabulation.

Results

Out of 150 cases, 55 (37%) were males and 95 (63%) were females (Figure 1)

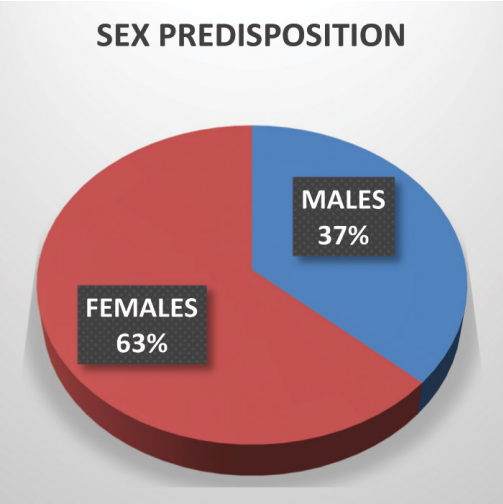

Fig. 1. Sex Distribution of the cases

Out of 55 males studied, 45 (35.71%) were positive and 10 (41.67%) were negative for culture and of 95 females 81 (64.29%) were positive and 14 (58.33%) were negative for the culture (Figure 2).

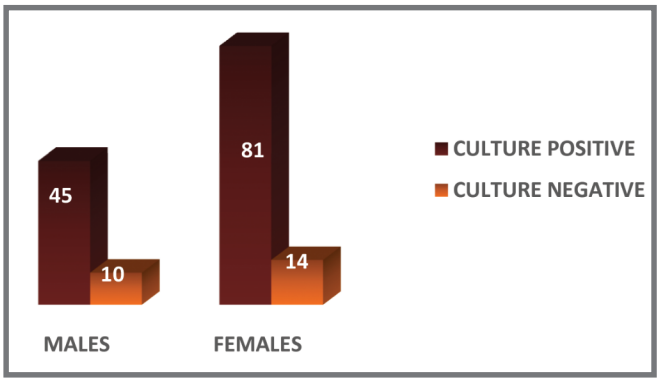

Fig. 2. Culture Positivity among different sex groups

Out of 150 cases, 37 (24.66%) cases were observed in 36-45 years age group. Out of 37 cases, 25 (26.32%) cases were females and 12 (21.82%) cases were males. 32 (21.33%) cases were observed between 26-35 years age group, 25 (16.67%) cases were observed between 16-25 years (Figure 3 & 4).

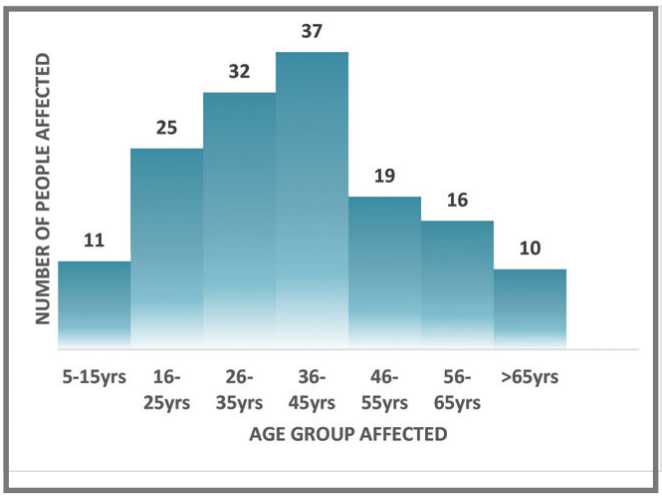

Fig. 3. Age Distribution of the cases

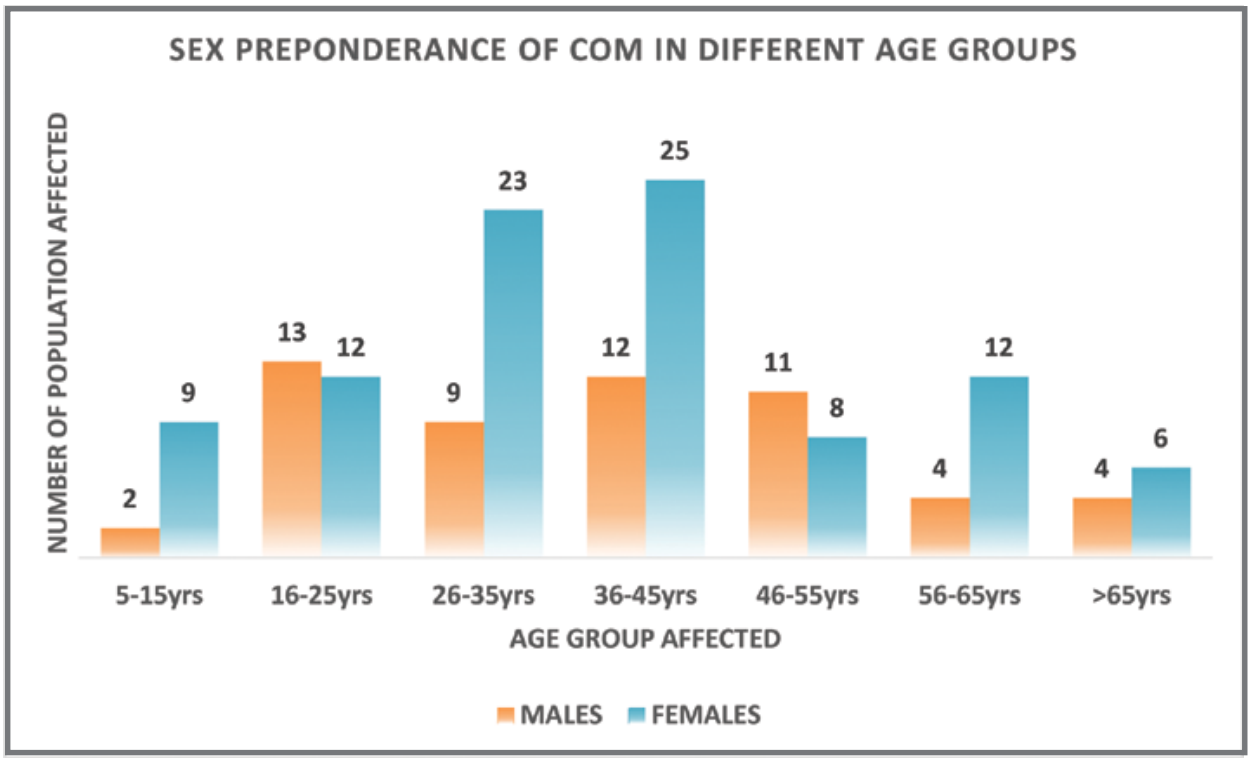

Fig. 4. Sex Preponderance of COM in different age groups.

In most of the age groups, female preponderance is seen, except in the 16-25 years and 46-55 years age groups (Figure 4).

Mucosal type of COM was encountered in 125 cases (83%) as compared to 25 (17%) Squamosal COM cases (Figure 5) and mostly the right ear (55%) was seen to be affected (Figure 6).

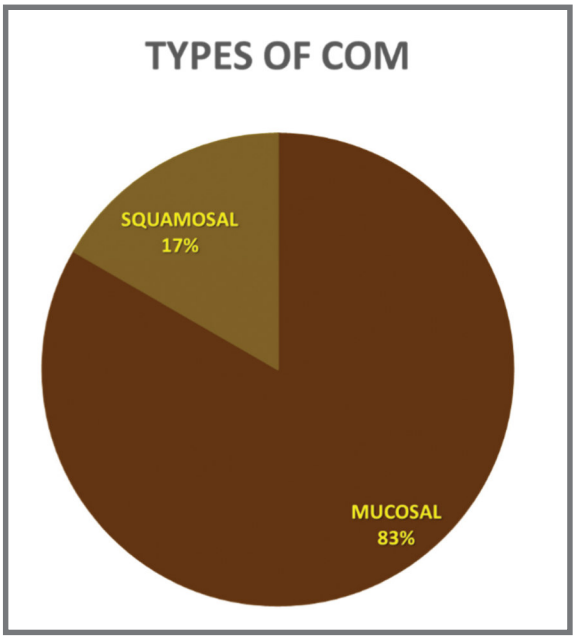

Fig. 5. Types of COM cases encountered

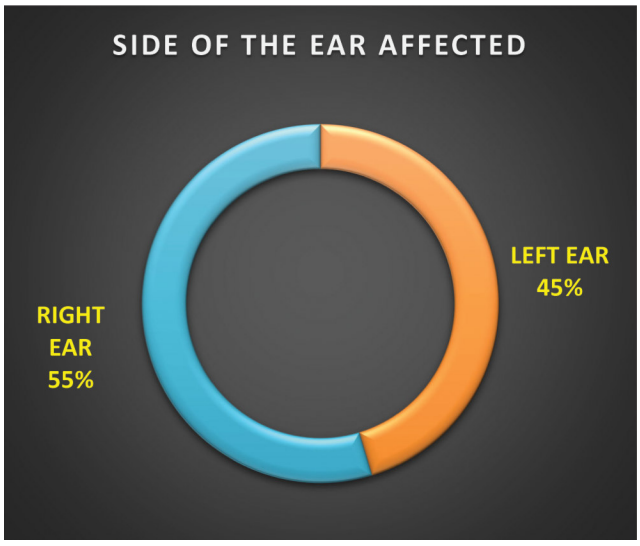

Fig. 6. Side of the ear affected in COM cases encountered

126 (84%) cases were culture positive and 24 (16%) cases yielded no growth on culture in this study (Figure 7).

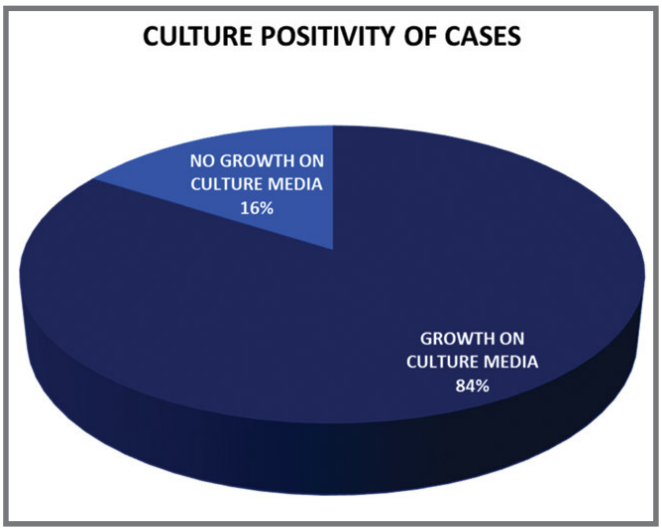

Fig. 7. Culture positivity of total COM cases

Among all the organisms isolated, *Pseudomonas aeruginosa* (30%), *Staphylococcus aureus* (22%) and *Klebsiella pneumoniae* (9.33%) were maximum in number. There were some atypical (rare) microbes also isolated, which include *Acinetobacter baumanii complex*, *Enterobacter cloacae complex*, *Stenotrophomonus maltophilia*, *Providencia stuartii*, *Proteus hauseri*, *Alkaligenes faecalis* (Figure 8) (Figure 9).

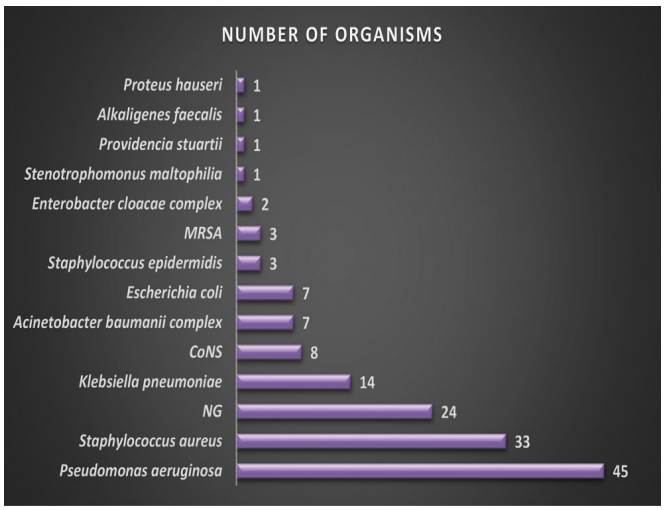

Fig. 8. Number of different microbes isolated in total COM cases studied

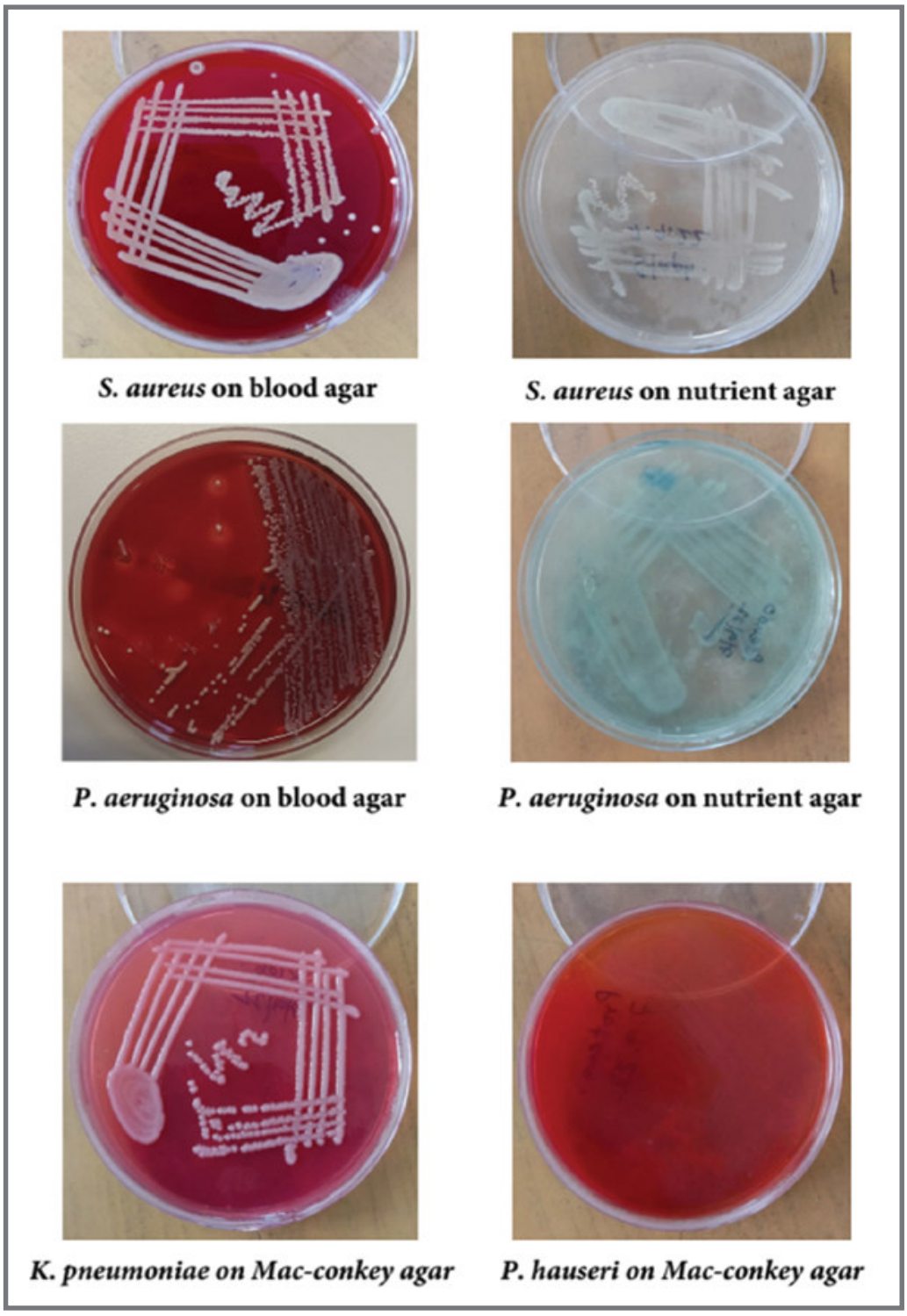

Fig. 9. Different bacterial isolates in different culture media

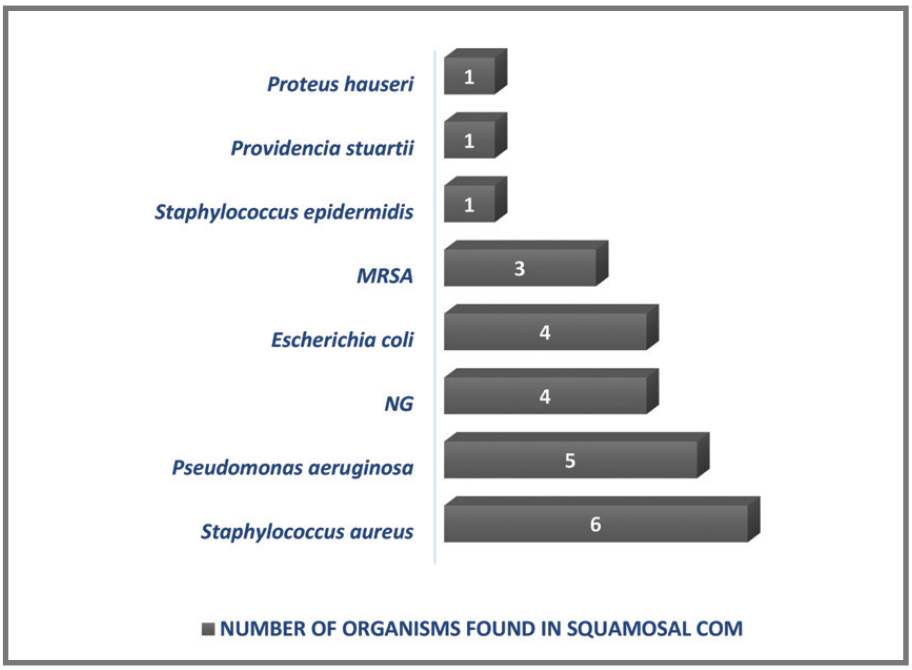

Fig. 10. Number of different microbes isolated in Squamosal COM cases studied

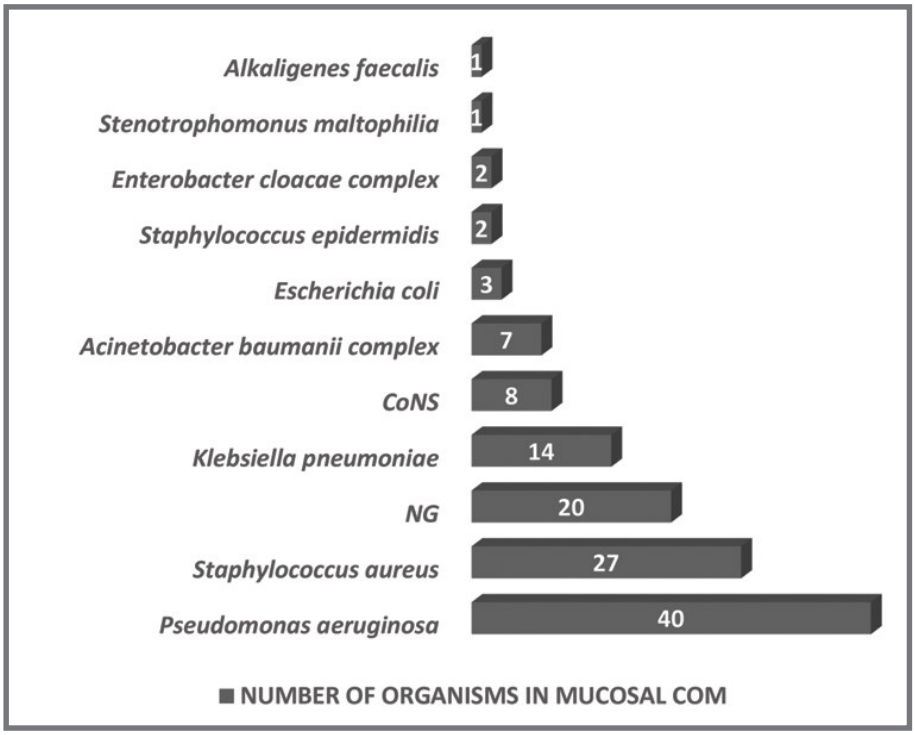

Fig. 11. Number of different microbes isolated in Mucosal COM cases studied

In squamosal COM cases, *S. aureus* (24%) isolates followed by *P. aeruginosa* (20%) were the most common (Figure 10); whereas in patients with mucosal COM, *P. aeruginosa* (32%) followed by *S. aureus* (21.6%) were most commonly isolated (Figure 11).

Gram-negative organisms (63%) outnumbered Gram-positive isolates (37%) (Figure 12). *S. aureus* (70%) and Coagulase negative Staphylococci (CoNS) (17%) were the most Gram-positive isolates (Figure 13) and among all Gram-negative isolates, *P. aeruginosa* (57%) and *K. pneumoniae* (18%) were the maximum (Figure 14).

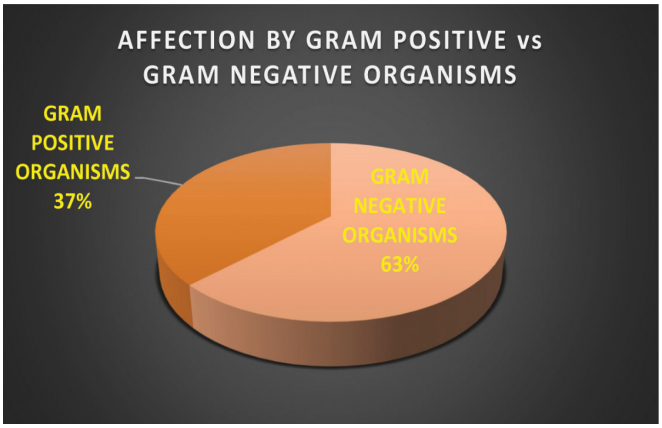

Fig. 12. Gram positivity of isolated organisms

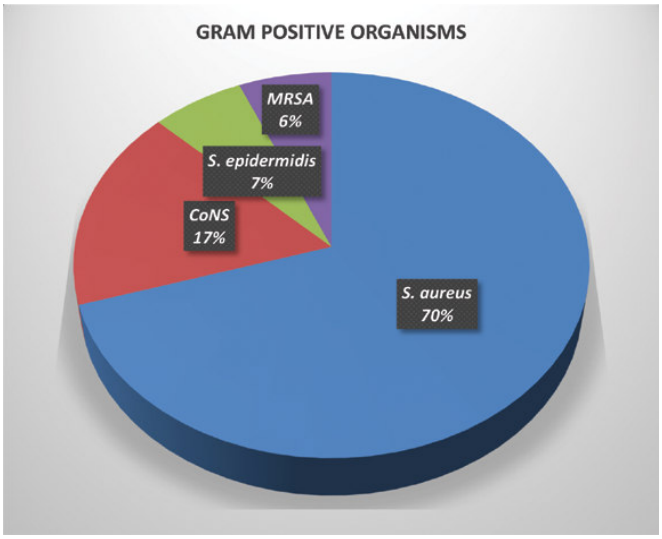

Fig. 13. Distribution of Gram-positive organisms

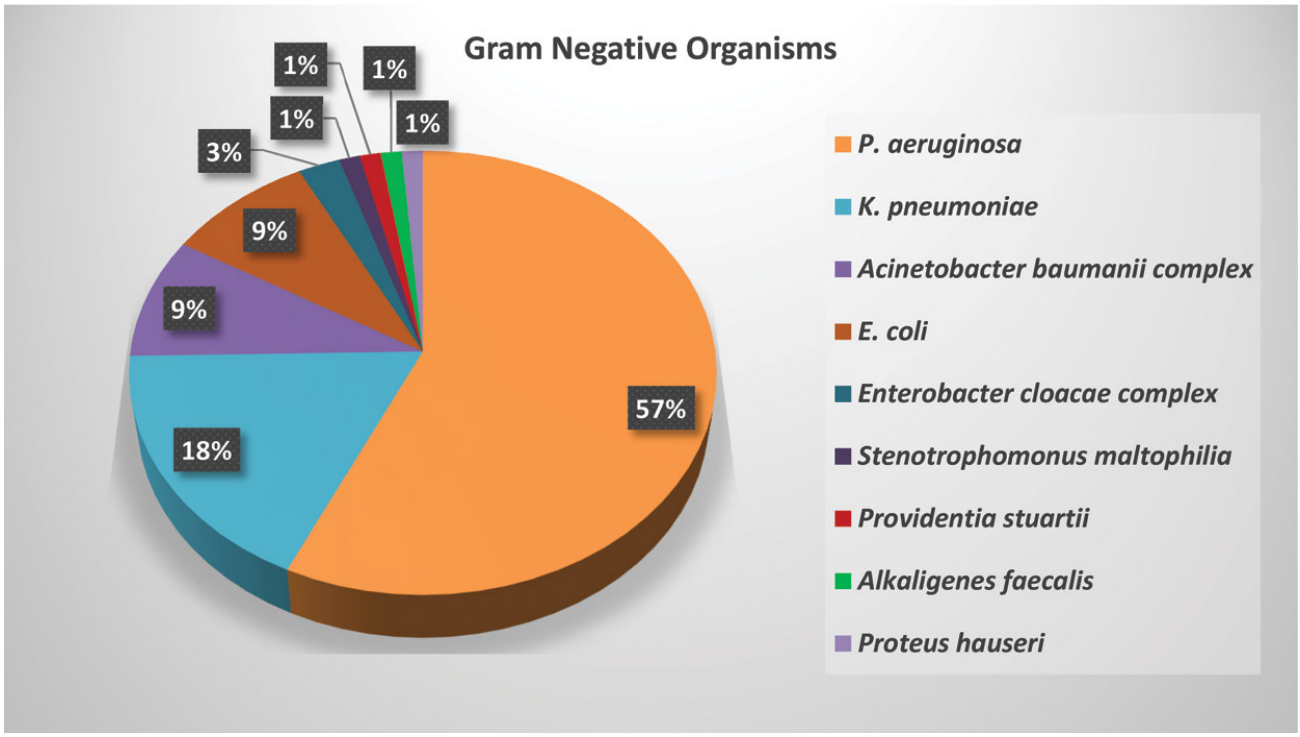

Fig. 14. Distribution of Gram-negative organisms

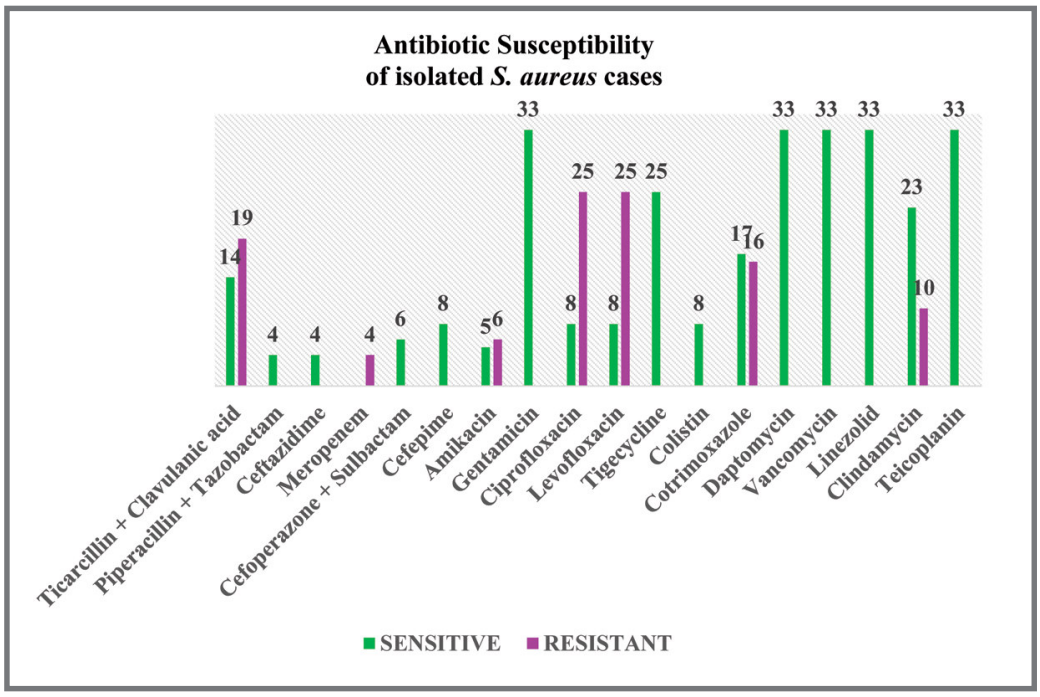

Fig. 15. Antibiotic Susceptibility of isolated *S. aureus* cases

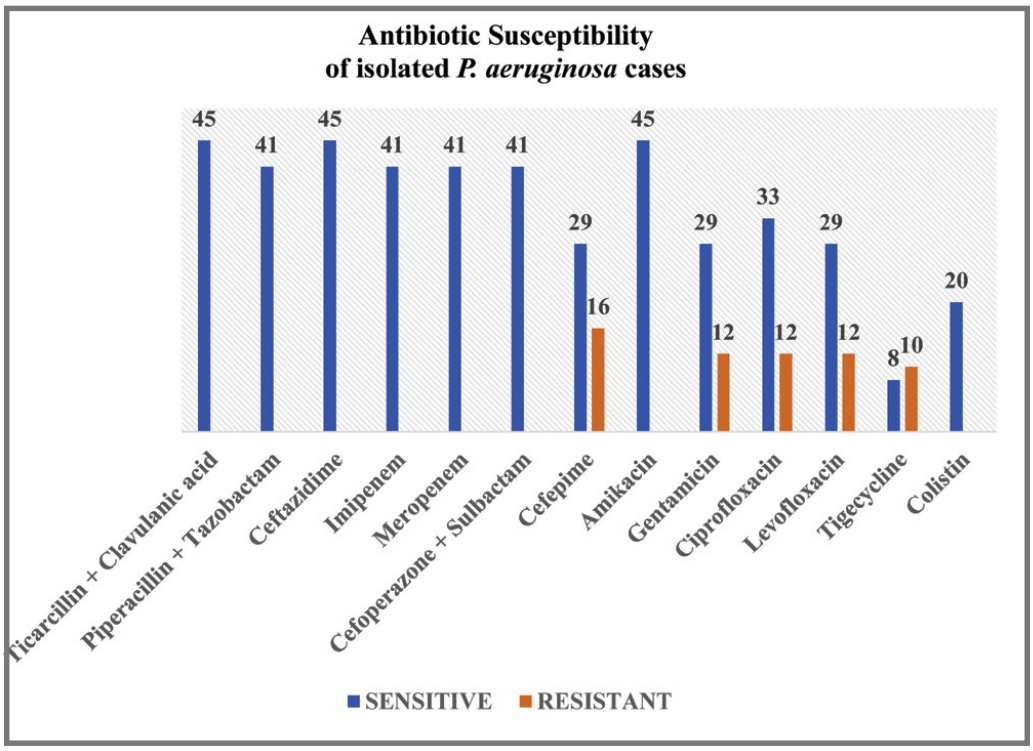

Fig. 16. Antibiotic Susceptibility of isolated *P. aeruginosa* cases.

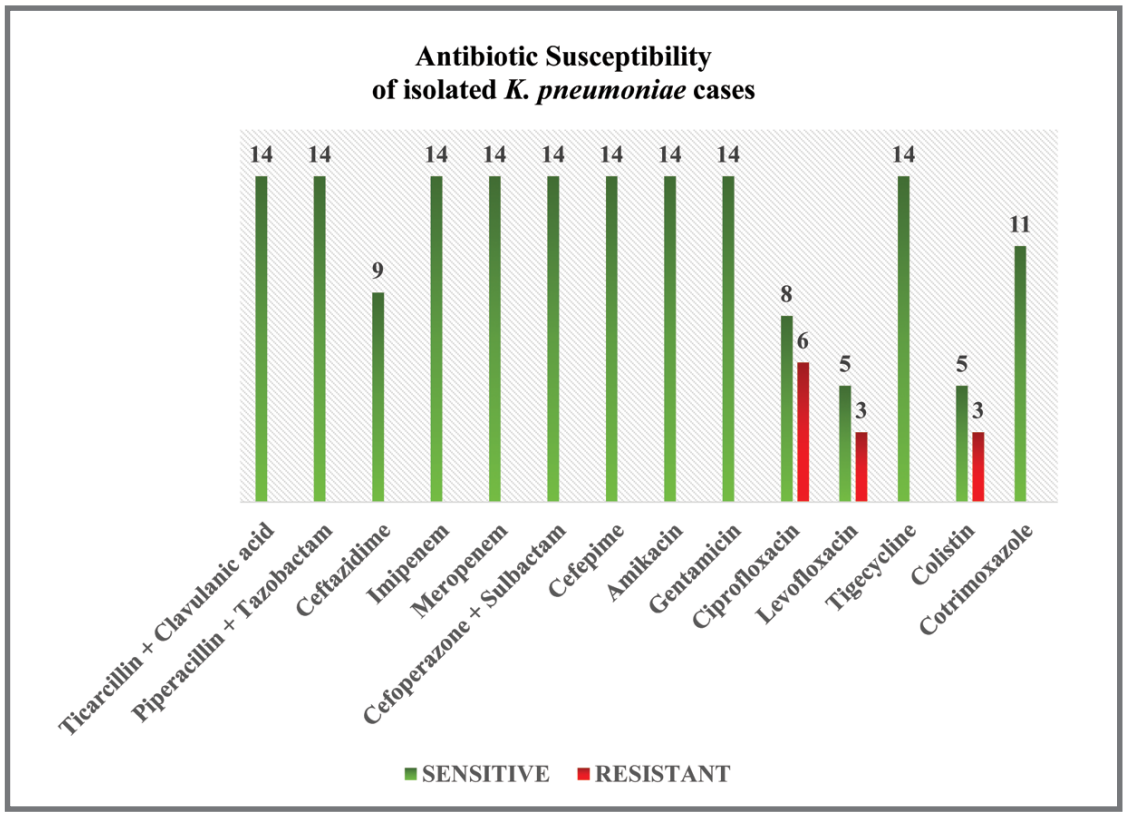

Fig. 17. Antibiotic Susceptibility of isolated *K. pneumoniae* cases.

The cases isolated with *S. aureus* were seemed to be much more sensitive to Gentamicin, Vancomycin, Daptomycin, Linezolid and Teicoplanin followed by Tigecycline, Clindamycin and Cotrimoxazole and were mostly resistant to Fluoroquinolones (Ciprofloxacin/ Levofloxacin), Meropenem, Amikacin and Ticarcillin + Clavulanic acid (Figure 15).

P. aeruginosa isolates had more sensitivity to Ticarcillin + Clavulanic acid, Ceftazidime, Amikacin followed by Piperacillin + Tazobactam, Imipenem, Meropenem and Cefoperazone + Sulbactam as well as to Fluoroquinolones (Ciprofloxacin> Levofloxacin), Cefepime, Gentamicin and Colistin. These are intrinsically resistant to Cotrimoxazole, thus sensitivity not checked (Figure 16).

The cultures, which yielded *K. pneumoniae*, were seemingly sensitive to most of the antibiotics except some cases had resistance against Fluoroquinolones (Ciprofloxacin/ levofloxacin) and Colistin (Figure 17).

Discussion

Bacteriological and fungal cultures are of potential value only when the ear is active or if there are infective complications. If systemic antibiotic therapy is being contemplated, culture of any secretions with antibiotic sensitivity pattern of any growths being assessed can be of value in deciding which antibiotic to prescribe as most do not cover the full range of bacteria that can be isolated as potential pathogens from the ear.

In a study by G. Sweeney et al, the cultured isolates showed 64% only aerobes, 32% both aerobes and anaerobes, and 5% had no growth.[3]

The predominant isolates in most of the studies were *Pseudomonas aeruginosa* and *Staphylococcus aureus*

followed by *Klebsiella spp.*, *Proteus spp.*, *Escherichia coli* and few studies also isolated *Serratia marcescens* and *Shelwanella spp.*[4] None of the patients in this study had been treated with oral or topical antibiotics for the previous 4 weeks.[5]

Some studies have shown no difference in the microbiological cultures between squamous epithelial disease and mucosal disease[3] whereas other studies have suggested that *Pseudomonas* is less common in squamous epithelial disease.[6]

It seems obvious and logical to assume that the activity of the ear in COM would be caused by pathogenic organisms. However, cultures from almost 50% of patients with inactive COM yield an identical flora to that found in active COM.[5]

Furthermore, although anaerobes can be isolated from 32% of ears, their elimination by metronidazole does not cause the ear to become inactive.[7]

Pseudomonas aeruginosa is not commonly found in the normal ear and rarely initiates acute infection. *Pseudomonas* is ubiquitous in our physical environment and has a predilection for moist areas. It is thought to infect tissues first by adherence to epithelial cells by means of pili or fimbriae.[8] *Pseudomonas* infections typically encounter resistance in normal tissues, unless there's cellular injury, as seen in chronic lung conditions like cystic fibrosis. This *"opportunistic adherence"* may play a crucial role in the development of middle ear infections, similar to respiratory infections. Therefore, bacteria in chronic otitis media (COM) can be viewed as secondary invaders following mucosal inflammation from other causes.

Bacteria primarily exist in Biofilms, which are complex, surface-attached communities offering advantages over planktonic forms. Biofilm bacteria demonstrate enhanced antimicrobial resistance and host defense, functioning as "*self-assembling multicellular communities*". These biofilms play a significant role in chronic infections. Studies to examine the presence of biofilms in active COM have shown a 60% biofilm incidence as opposed to 10% in the control, uninfected group.[9] Biofilms are more abundant in squamous OM, where 82% of cholesteatoma ears were found to have biofilms as opposed to 42% of the mucosal COM and 9% of the control, normal middle ear (cochlear implant) group.[10]

The bacteria cultured in paediatric COM with cholesteatoma are similar to those in adult disease. Studies show that in children with cholesteatoma *Pseudomonas aeruginosa*, *Proteus mirabilis* and *Staphylococcus aureus* are the most common isolates.[11]

There was no significant geographical variation of pathogens in India. Recently, the rise of multidrug-resistant organisms, due to irrational antibiotic use, has made CSOM treatment more difficult. Colistin and polymyxin-B showed up to 100% effectiveness against *P. aeruginosa*, while carbapenems exhibited good sensitivity, though sensitivity to piperacillin-tazobactam, amikacin, gentamicin, ceftazidime, and ciprofloxacin declined. Nine studies found methicillin-sensitive *S. aureus* to be more prevalent than methicillin-resistant strains. For *S. aureus*, vancomycin and linezolid showed e" 90% sensitivity, with amikacin, gentamicin, erythromycin, and ciprofloxacin demonstrating significant resistance.[4]

In five studies which isolated anaerobic bacteria, *Bacteroides fragilis* was isolated as the most common pathogen followed by *Prevotella spp.*, *Fusobacterium spp.*, and *Clostridium spp.*[4]

Furthermore, fungi are frequently found within CSOM samples, specifically *Aspergillus spp.* and *Candida spp.* Only Juyal et al. reported *Penicillium spp.* and *Mucor* in their study.[4] There are some speculations that fungi may result as overgrowth after initial treatment with antibiotic drops.

The bacteria that have been identified in children with post-tympanostomy otorrhea include *Haemophilus influenzae* (41%), *S. aureus* (40%), *P. aeruginosa* (18%), and *Streptococcus pneumoniae* (7%).[12]

In our study, about 25% cases were observed in 36-45 years age group, which is similar to the studies done by TU Samanth et al,[13] Jianghong Xu et al[14] and MR Khatun et al.[15] Although most of the studies shown higher number in school-going ages (11-20yrs).[16-21] This

difference in our study may be due lack of consciousness in parents of the children, being screened in this study.

There was a female preponderance in our study (about 63% cases were females), which is in accordance with the studies done by A Sharma et al,[22] B Sikder et al[23] and ML Casselbrant et al.[24]

Gram negative organisms (63%) outnumbered the Gram positives (37%) in culture positive cases as also evident from most of the studies.[25-27]

Among all the organisms isolated, *Pseudomonas aeruginosa* (30%) and *Staphylococcus aureus* (22%) followed by *Klebsiella pneumoniae* (9.33%) forms the major bulk isolated in our cases. This finding seemed to be consistent with the study results of R Sharma et al,[28] A Mallick et al[(29)] and D Juyal et al.[30]

The cases isolated with *S. aureus* were seemed to be much more sensitive to Gentamicin, Vancomycin, Daptomycin, Linezolid and Teicoplanin followed by Tigecycline, Clindamycin and Cotrimoxazole and resistant to Fluoroquinolones (Ciprofloxacin/ Levofloxacin), Meropenem. Amikacin, Ticarcillin + Clavulanic acid. These results were mostly similar to that of the studies by TU Samanth et al,[13] R Sharma et al,[28] M Nagraj et al,[31] A Agarwal et al,[32] and S Rathi et al.[33]

Isolated *P. aeruginosa* cases were seemingly more sensitive to Ticarcillin + Clavulanic acid, Ceftazidime, Amikacin followed by Piperacillin + Tazobactam, Imipenem, Meropenem and Cefoperazone + Sulbactam, along with Fluoroquinolones (Ciprofloxacin> Levofloxacin), Cefepime, Gentamicin and Colistin. These findings also somewhat match with the results of R Sharma et al,[28] A Agarwal et al,[32] ST Rangaiah et al[(34)] and KA Deshmukh et al.[35]

Conclusion

Chronic otitis media (COM) is a disease with female preponderance and *Pseudomonas aeruginosa* and *Staphylococcus aureus*, being the common microbes associated with it. The patients should be advised to take drugs for the complete prescribed duration as per the culture sensitivity reports obtained, to avoid resistance. The antibiotic susceptibility patterns must be continuously and periodically assessed to prevent the emergence of resistant strain and to decrease the potential risk of complications.

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