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ORIGINAL ARTICLE

Bacteriological Profile in Attico-antral type of Chronic Suppurative Otitis Media

Tamanna Mahajan[1] · Arjun Dass[1] · Nitin Gupta[1] · Jagdish Chander[2] · Vaibhav Saini[1] · Shashikant A. Pol[1]

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Abstract Chronic suppurative otitis media is defined as a chronic inflammation of the middle ear cleft, which presents with recurrent ear discharge through a tympanic membrane perforation. The purpose of this study was to find pattern of bacteriology in patients of atticoantral type of chronic suppurative otitis media as it will help the clinician to decide the effective antibiotics to be prescribed. This prospective and observational study was conducted in the Department of ENT in collaboration with Department of Microbiology, Government Medical College and Hospital, Chandigarh. The ear discharge specimen of all patients meeting the inclusion criteria were collected and sent for microbial examination. Culture positive samples were subjected to antibiotic sensitivity. A total of one hundred ears (mean age 27.33 years) clinically diagnosed with chronic suppurative otitis media, atticoantral type were included in this study based on the preset inclusion and exclusion. The male: female ratio in our patients was 0.94:1. Ninety-seven (96.9%) patients had unilateral disease, while 3 (3.1%) patients had bilateral disease. Twenty-eight percent of the total samples were sterile. The most common bacteria isolated were *Pseudomonas aeruginosa* (27.1%), Methicillin sensitive *Staphylococcus aureus* (23.3%) and *Proteur mirabilis* (6.5%). was sensitive to polymyxin B (100%) followed by ciprofloxacin (46.4%), neomycin (42.9%) and gentamicin (42.9%). Polymyxin B is the most effective antibiotic against the cultured bacteria followed by gentamicin, ciprofloxacin and neomycin.

Keywords Chronic suppurative otitis media · Atticoantral · Bacteriological profile · Antibiotic sensitivity

Introduction

Chronic suppurative otitis media is defined as a chronic inflammation of the middle ear cleft, which presents with recurrent ear discharge through a tympanic membrane perforation. The disease usually begins in childhood as a spontaneous perforation of tympanic membrane due to an acute infection of the middle ear, known as acute otitis media (AOM), or as a sequel of less severe forms of otitis media e.g. secretory otitis media.

In CSOM, the bacteria may be aerobic i.e. *Pseudomonas aeruginosa*, *Escherichia coli*, *S. aureus*, *Streptococcus pyogenes*, *Proteus mirabilis*, *Klebsiella* species or anaerobic i.e. Bacteroides, Peptostreptococcus, Propionibacterium [1–3]. The bacteria are infrequently found in the skin of the external auditory canal, but may proliferate in the presence of trauma, inflammation, lacerations or high humidity. These bacteria may then gain entry to the middle ear through a chronic perforation [4]. Studies on the microbiology of CSOM have revealed that the most common bacteria associated with CSOM are *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Proteus* spp., and *Klebsiella pneumonia* [5–7]. A few other studies showed *Staphylococcus aureus* as the most common bacteria, especially if cholesteatoma was present [8].

CSOM is usually classified into two types, tubotympanic and attico-antral depending on whether the disease process affects the pars tensa or pars flaccida of the tympanic

✉ Nitin Gupta
nitinent123@gmail.com

[1] Department of ENT, Govt Medical College and Hospital, Sector-32, Chandigarh, India

[2] Department of Microbiology, Govt Medical College and Hospital, Sector-32, Chandigarh 160030, India

membrane [9]. Tubotympanic CSOM is called as safe or benign type as there are no serious complications, whereas, attico-antral type is called as the unsafe or dangerous type because of associated complications and may be life threatening at times [10], that can be separated into 2 subgroups: intratemporal and intracranial [11]. Intratemporal complications include petrositis, facial paralysis, and labyrinthitis. Intracranial complications include lateral sinus thrombophlebitis, meningitis, and intracranial abscess. Sequelae include hearing loss, acquired cholesteatoma, and tympanosclerosis.

Aggressive management is necessary as untreated and poorly treated unsafe CSOM can result in a variety of complications. Complications associated with CSOM have reduced after the introduction of antibiotics; however, irrational use of antibiotics has led to the emergence of multi-drug resistant bacterial strains and disease complications in return [12].

As the aim of treatment in cases of unsafe CSOM is to control infection and eradicate the disease by mastoid surgery, an understanding of the common pathogens involved in unsafe CSOM, culture and sensitivity for antibiotic and antibiotic resistance will help us in making a correct choice of antibiotic.

The prevalence and antibiogram of these organisms has been reported to vary with time and geographical area, therefore, knowledge of local micro-organism pattern is essential for effective and low cost treatment [13]. The purpose of this study was to find the local pattern of bacteriology in patients of atticoantral type of chronic suppurative otitis media as no such study has been conducted previously in this part of the country as it will help the clinician to decide the effective antibiotics to be prescribed. The current study will explore details regarding the bacterial profile in atticoantral type of CSOM in patients coming to this institution.

Aims and Objectives

1. To find out spectrum of bacteria in cases of atticoantral type of chronic suppurative otitis media and their antibiotic sensitivity.
2. To compare the bacteriological profile in different sub-groups of patients.

Materials and Methods

This study was conducted in the Department of ENT in collaboration with Department of Microbiology, Government Medical College and Hospital, Chandigarh. After considering the previous years' OPD registration attendance records, a minimum of one hundred ears were included in the study, which were clinically diagnosed cases of chronic suppurative otitis media attico-antral type.

Inclusion Criteria

All patients of any age or sex, clinically diagnosed with chronic suppurative otitis media attico-antral type as per WHO definition (2004) [14].

Exclusion Criteria

- Patients not giving consent for the study.
- Patients with tubotympanic type CSOM.
- Patients who received topical/systemic antibiotics within one week of presentation.
- Patients receiving steroids, chemotherapy or radiotherapy.
- Patients diagnosed with any immunodeficiency or autoimmune disorder.
- Patients diagnosed with any malignant lesion of external and middle ear.
- Patients who had undergone any previous surgery of the affected ear.

The ear discharge specimen of all patients meeting the inclusion criteria were collected.

Collection of Sample

Aseptic techniques were observed in the collection of specimens by cleaning external auditory canal with sterile cotton pledget soaked in 70% alcohol or povidone-iodine and was collected in three sterile cotton swab sticks (one for aerobe culture, one for anaerobe culture and third for AFB staining) avoiding contact with external auditory canal walls.

Microbiological Examination

The swabs were taken for aerobic and anaerobic incubation as per standard protocols and results were recorded after 48–72 hours of incubation. Those organisms, which failed to grow aerobically, were considered as anaerobes [15].

The culture isolates were studied for their sensitivity to the antibiotics namely-ciprofloxacin, gentamicin, cotrimoxazole, cefixime, amoxicillin + clavulanic acid, chloramphenicol, methicillin, erythromycin, polymyxin B, neomycin and ofloxacin.

The data was compiled and statistically analyzed to present the results in form of numbers and percentages. The study was conducted on the ethical guidelines for

biomedical research on human subject as given in the "Declaration of Helsinki" and by Central Ethics Committee on Human Research (CECHR) of ICMR, New Delhi [16].

Results

A total of 97 patients clinically diagnosed with atticoantral type of CSOM were included in this study based on the preset inclusion and exclusion criteria. The mean age of the patients was 27.33 years, with the peak age group between 10 and 19 years with a standard deviation of 16.18 years. Minimum age of the patients was 1 year and maximum age was 70 years. Forty-eight and a half percent of the patients were males, while 51.5% of the patients were females. The male: female ratio in our patients was 0.94:1. Ninety-seven (96.9%) patients had unilateral disease, while 3 (3.1%) patients had bilateral disease. For the purpose of analysis, results are presented as the number of ears. So, a total of 100 ear swabs were taken and divided into paediatric and adult; rural and urban (Table 1). The difference between the groups was not statistically significant ($p = 0.743$).

Majority of the swabs (72%) were culture positive and 28% were sterile. Out of them, adults contributed to 82.1% of sterile specimens. Out of the positive samples, pediatric age group were 38.9% and 61.1% from adult age group (as shown in Fig. 1).

The culture results were found to be only aerobic bacteria. None of the bacteria were anaerobic in this study. Gram staining of the bacteria was done (distribution shown in Fig. 2).

It was found that of the positive culture specimens, most commonly isolated bacteria was *Pseudomonas aeruginosa* (27.1%) followed by *Staphylococcus aureus* (considering both methicillin sensitive and methicillin resistant forms) (23.3%) being the second most common bacteria. In paediatric population also, *Pseudomonas aeruginosa* (27.0%) was the most common isolate. *Staphylococcus aureus*

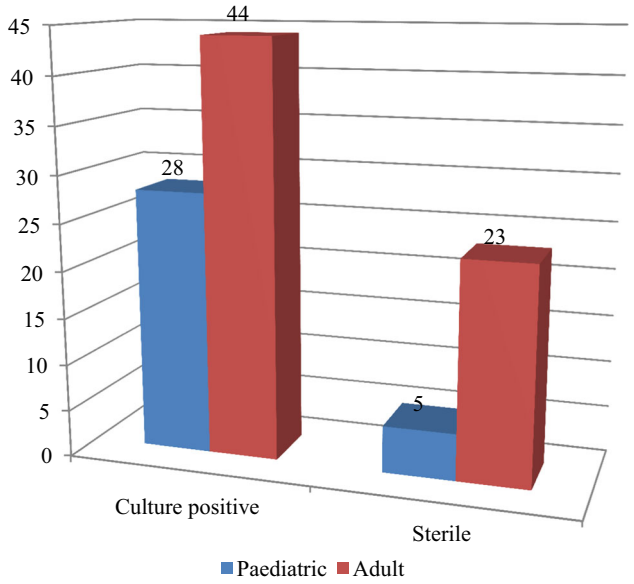

Fig. 1 Culture positivity of specimens

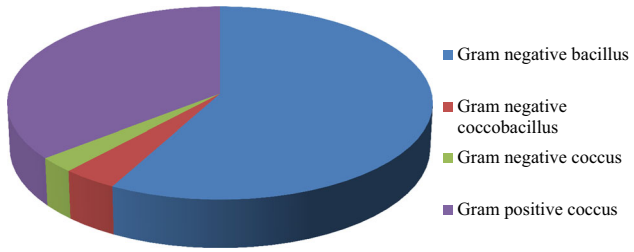

Fig. 2 Gram staining of bacteria

(18.9%) (Considering both methicillin sensitive and methicillin resistant) was found to be second most common isolate. It was followed by Proteus mirabilis (16.2%). The adult population showed almost equal frequency of *Pseudomonas aeruginosa* (27.1%) and *Staphylococcus aureus* (25.7%). Sterile cultures were more common in adults (32.9%) than paediatric population (13.5%). Proteus mirabilis included 6.5% of the isolates followed by *Klebsiella pneumoniae* (2.8%) and *Acinetobacter coloaceticus*

Table 1 Age and sex wise distribution of the population under study

			Age group	
			Paediatric	Adult
Sex	Female	Count	15	35
		Percentage	45.5	54.7
	Male	Count	18	29
		Percentage	54.5	45.3
Total		Count	33	64
		Percentage	100.0	100.0

(2.8%). Coagulase negative *Staphylococcus aureus* comprised of 1.9% of isolates along with *Enterococcus faecium* (1.9%) and Escherichia coli (1.9%). *Enterobacter cloacae* (0.9%), *Enterococcus faecium* (0.9%), *Klebsiella oxytoca* (0.9%) and Methicillin resistant *Staphylococcus aureus* (MRSA) (0.9%) comprised of one specimen each. The culture results of bacteria are shown in Table 2 (Fig. 3).

Among the tested antibiotics, polymyxin B (100.0%) is the most effective antibiotic in both paediatric as well as adult population for *Pseudomonas aeruginosa*. It is followed by ciprofloxacin (46.4%), neomycin (42.9%) and gentamicin (42.9%). Hundred percent of both adult and paediatric samples showed sensitivity to polymyxin B. It was found to be most resistant to methicillin in 100% cases followed by cefixime in 92.5%, erythromycin in 92.5%, co-amoxyclav in 82.1%, cotrimoxazole in 75.0%, chloramphenicol in 75.0%, ofloxacin in 75.0%, neomycin in 57.1% and gentamicin in 57.1% as shown in Table 3.

Methicillin sensitive *Staphylococcus aureus* shows sensitivity to methicillin (100.0%), gentamicin (95.8%), co-amoxyclav (95.8%), chloramphenicol (87.5%), polymyxin B (75.0%) and ofloxacin (75.0%) in the decreasing order. Adult cases showed 100% sensitivity to erythromycin and co-amoxyclav and gentamicin while paediatric patients showed 61.1% sensivity to erythromycin and 94.4% sensitivity to each of gentamicin and co-amoxyclav. MSSA was found to be resistant to cefixime in 58.3% cases and to neomycin in 50% of cases as shown in Table 4.

Proteus mirabilis was found to be sensitive to ciprofloxacin (100.0%) and ofloxacin (85.7%). Ofloxacin was found to be 100% sensitive in paediatric population and 83.3% sensitive in adult population. It was found to be

Table 2 Bacteriology of tested specimens

Culture result		Age groups	
		Paediatric	Adult
Acinetobacter coloaceticus	Count	2	1
	Percentage	5.4	1.4
Coagulase negative *Staphylococcus aureus* (CONS)	Count	1	1
	Percentage	2.7	1.4
Enterobacter cloacae	Count	0	1
	Percentage	0	1.4
Enterococcus faecalis	Count	1	1
	Percentage	2.7	1.4
Enterococcus faecium	Count	1	0
	Percentage	2.7	0
Escherichia coli	Count	1	1
	Percentage	2.7	1.4
Klebsiella oxytoca	Count	0	1
	Percentage	0	1.4
Klebsiella pneumonia	Count	1	2
	Percentage	2.7	2.9
Methicillin resistant *Staphylococcus aureus* (MRSA)	Count	1	0
	Percentage	2.7	0
Methicillin sensitive *Staphylococcus aureus* (MSSA)	Count	6	18
	Percentage	16.2	25.7
Proteus mirabilis	Count	6	1
	Percentage	16.2	1.4
Proteus vulgaris	Count	2	1
	Percentage	5.4	1.4
Pseudomonas aeruginosa	Count	10	19
	Percentage	27.0	27.1
Sterile	Count	5	23
	Percentage	13.5	32.9

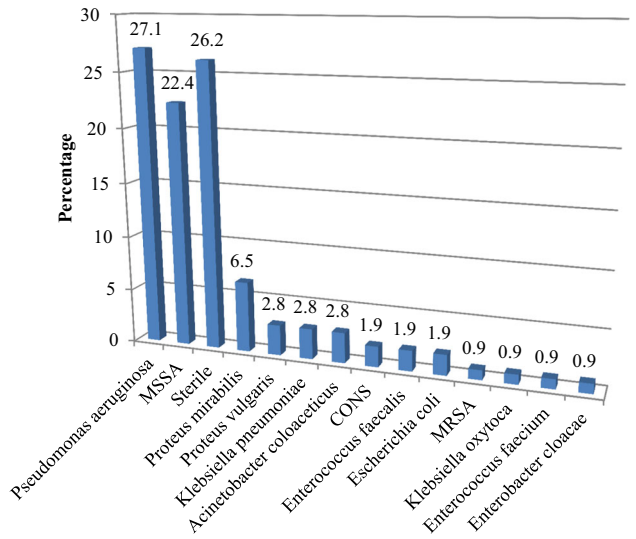

Fig. 3 Bacteriological profile of tested specimen

100% resistant to polymyxin B (85.7%) followed by erythromycin and methicillin (85.7%).

Proteus vulgaris shows sensitivity to ciprofloxacin (100.0%), ofloxacin (100.0%), neomycin (66.7%), gentamycin (66.7%), cotrimoxazole (66.7%), and cefixime (66.7%) and is resistant to all other antibiotics under study.

Klebsiella pneumoniae was most sensitive to co-amoxyclav (100.0%), polymyxin B (100.0%) and methicillin (100.0%) followed by neomycin (66.7%), gentamycin (66.7%), chloramphenicol (66.7%), cefixime (66.7%) and cotrimoxazole (66.7%). It was resistant to all other antibiotics under study.

Acinetobacter was found to be sensitive to most of the antibiotics under study except for methicillin which was resistant in 100% of cases, followed by neomycin and polymyxin B, each of which are resistant in 66.7% of the cases.

Only two samples of Coagulase negative *Staphylococcus aureus* (CONS) were isolated and were found to be sensitive to all the antibiotics under study except for ciprofloxacin and polymyxin B in which it showed 50% resistance with no difference in adult and paediatric population.

100% resistance was found to cefixime and methicillin in case of *Enterococcus faecalis* and 50% resistance to cotrimoxazole. It was found to be sensitive to all other antibiotics under study.

Escherichia coli was sensitive to all the antibiotics except for methicillin to which it was 100% resistant and cotrimoxazole to which it was 50% resistant. There was no difference in adult and paediatric data.

Enterococcus faecium was isolated in only one adult sample and it was found to be resistant to cefixime and methicillin. It was found to be sensitive to rest of the antibiotics.

Enterobacter cloacae was found in just one pediatric sample and it was found to be sensitive to most of the antibiotics except for chloramphenicol, polymyxin B, methicillin and neomycin.

Klebsiella oxytoca was isolated in one paediatric sample and it was sensitive to only ciprofloxacin, ofloxacin, polymyxin B and gentamicin. It was resistant to rest of the antibiotics.

Methicilllin resistant Staphylococcus aureus (MRSA) was found in only one adult specimen and was found to be resistant to methicillin, cefixime, cotrimoxazole and neomycin. It was found sensitive to rest of the antibiotics.

Discussion

In our study, a total of 97 patients participated who were diagnosed as a case of atticoantral type of CSOM out of which three patients had bilateral disease. These patients were divided into two groups—paediatric and adult. We found an almost equivalent male and female distribution in the population under study with the male to female ratio being 0.94:1 with a slight female preponderance. This is in correspondence to study done by Lakshmi et al. and Shrestha et al. [17, 18] which have shown female predominance. Some studies have found males to have a higher and more recurrent episode of otitis media than females like Teele et al. and Agrawal et al. [19, 20] in which males were 53.6% and females were 46.4%. Differences in sexual preponderance is incidental, and has no anatomical factors predisposing either sex to the development of CSOM. The mean age of the patients was 27.33 years, with the peak age group between 10 and 19 years which is in correspondence with the studies of Aggrawal et al., and other authors like Shyamala et al. and Gulati et al. [20–22].

It is seen that majority of the patients in our study belong to rural areas (58.8%). This is in agreement with various studies performed by Kumar ans seth, Malkappa et al. and Taneja [9, 23, 24]. According to the study by Shaheen et al., more than half of the study samples were from low income group where chronic otitis media was also more prevalent. It also showed that the children, who used to take bath in the pond or river water, were affected more by CSOM, which was statistically significant [25]. Rural population is affected more than urban due a variety of reasons like illiteracy, lack of awareness, poor sanitation, lack of health facilities and difference in lifestyle like people in rural India are still taking bath in ponds, rivers and wash clothes and utensils in the same water. These factors can be attributed to higher incidence in rural areas.

Table 3 Antibiotic sensitivity for *Pseudomonas aeruginosa*

		Category				Total
		Adult		Pediatric		
		n	%	n	%	n
Erythromycin	Resistant	9	90.0	17	94.4	26
	Sensitive	1	10.0	1	5.6	2
Total		10	100.0	18	100.0	28
Ciprofloxacin	Resistant	4	40.0	11	61.1	15
	Sensitive	6	60.0	7	38.9	13
Total		10	100.0	18	100.0	28
Gentamicin	Resistant	4	40.0	12	66.7	16
	Sensitive	6	33.3	6	33.3	12
Total		10	100.0	18	100.0	28
Cotrimoxazole	Resistant	7	70.0	14	77.8	21
	Sensitive	3	30.0	4	22.2	7
Total		10	100.0	18	100.0	28
Chloramphenicol	Resistant	6	60.0	15	83.3	21
	Sensitive	4	40.0	3	16.7	7
Total		10	100.0	18	100.0	28
Cefixime	Resistant	10	100.0	16	88.9	26
	Sensitive	0	0.0	2	11.1	2
Total		10	100.0	18	100.0	28
Amoxicillin–clavulanic acid	Resistant	7	70.0	16	88.9	23
	Sensitive	3	30.3	2	11.1	5
Total		10	100.0	18	100.0	28
Polymyxin B	Resistant	0	0.0	0	0.0	0
	Sensitive	10	100.0	18	100.0	28
Total		10	100.0	18	100.0	28
Methicillin	Resistant	10	100.0	18	100.0	28
	Sensitive	0	0.0	0	0.0	0
Total		10	100.0	18	100.0	28
Neomycin	Resistant	4	40.0	12	66.7	16
	Sensitive	6	40.0	6	33.3	12
Total		10	100.0	18	100.0	28
Ofloxacin	Resistant	7	70.0	14	77.8	21
	Sensitive	3	30.0	4	22.2	7
Total		10	100.0	18	100.0	28

A wide variety of bacteria of CSOM were isolated from the population in our study. Out of the total 100 samples, 72(72%) specimens were culture positive and 28(28%) samples were sterile showing no growth. A similar trend was noticed by Kumar and Seth [9] in which 16% cases were negative for any growth. Other studies have also shown sterile cultures like 10% noticed by Saraswati et al. and 9.8% by Ahmed et al. [26, 27]. More percentage of culture sterile specimens may be attributed to the factors like scanty discharge in case of unsafe CSOM, and that the discharge may be due to osteolytic reactions and granulations in the middle ear or the discharge may be due to non bacterial etiology. Our hospital is a tertiary care hospital and most of the patients have already been exposed to some form of the treatment or the other. Erroneous techniques like faulty collection of discharge, delay in transportation, culture processing, contamination of samples etc., cannot be ruled out as a cause of sterile results.

In our study, three out of 72 culture positive specimens showed polymicrobial growth. This accounts for 4.2% of the total culture positive specimens. A similar result was

Table 4 Antibiotic sensitivity for *Staphylococcus aureus* (MSSA)

		Category				Total
		Adult		Pediatric		
		n	%	n	%	n
Erythromycin	Resistant	0	0.0	7	38.9	7
	Sensitive	6	100.0	11	61.1	17
Total		6	100.0	18	100.0	24
Ciprofloxacin	Resistant	3	50.0	8	44.4	11
	Sensitive	3	50.0	10	55.6	13
Total		6	100.0	18	100.0	24
Gentamicin	Resistant	1	5.5	0	0.0	1
	Sensitive	17	94.4	6	100.0	23
Total		6	100.0	18	100.0	24
Cotrimoxazole	Resistant	2	33.3	6	33.3	8
	Sensitive	4	66.7	12	66.7	16
Total		6	100.0	18	100.0	24
Chloramphenicol	Resistant	0	0.0	3	16.7	3
	Sensitive	6	100.0	15	83.3	21
Total		6	100.0	18	100.0	24
Cefixime	Resistant	4	66.7	10	55.6	14
	Sensitive	2	33.3	8	44.4	10
Total		6	100.0	18	100.0	24
Amoxicillin–clavulanic acid	Resistant	0	0.0	1	5.6	1
	Sensitive	6	100.0	17	94.4	23
Total		6	100.0	18	100.0	24
Polymyxin B	Resistant	2	33.3	4	22.2	6
	Sensitive	4	66.7	14	77.8	18
Total		6	100.0	18	100.0	24
Methicillin	Resistant	0	0.0	0	0.0	0
	Sensitive	6	100.0	18	100.0	24
Total		6	100.0	18	100.0	24
Neomycin	Resistant	5	83.3	7	38.9	12
	Sensitive	1	16.7	11	61.1	12
Total		6	100.0	18	100.0	24
Ofloxacin	Resistant	1	16.7	5	27.8	6
	Sensitive	5	83.3	13	72.2	18
Total		6	100.0	18	100.0	24

obtained by a study done in Karnataka in 2016 which showed single microbial isolate in 80% of cases and multiple bacteria in 5.2% of cases [28]. Pure growth was found in 82% cases and mixed growth in 10% [29]. The monomicrobial bacterial isolate was seen in 100 (80%) cases. The mixed growth (contamination) was observed in 10 (8%) cases [20]. Of the ears showing growth, 90.90% showed monomicrobial growth while 9.09% of the cases showed polymicrobial growth [30]. The studies done by Malkappa et al. and Ettahad et al. [23, 31] on the other hand yielded only monomicrobial growth. In contrast to these studies, a study done in Iraq revealed pure cultures in only 30.1% of ear discharges while the remaining showed mixed growth [32]. Another Egyptian study showed 63.5% samples had a single organism and 36.4% had polymicrobial growth [27]. This disparity in results may be due to different environmental conditions which may lead to growth of different types of bacteria at different times. The other difference could have been due to the difference in the patient population studied and geographical variations. Temperature variations may be a contributing factor as mixed growths are seen in more tropical countries.

Our study comprised of only aerobic bacteria and none of the samples were positive for anaerobes. A similar trend was seen in study done by Kumar et al. [30] in which there were 97.8% aerobes; no anaerobes and 2.1% fungi. Majority of samples (92.8%) were aerobic bacteria as seen by Ghosh et al. [33]. Similarly, no anaerobes were isolated in a recent study done in 2016 by Rangaiah et al. in Mandya Medical College [28]. This is in contrary to the belief that anaerobic infections are more common in atticoantral type of CSOM.

The prevalence of gram negative bacteria 50 (64.1%) was more than gram positive bacteria 28 (35.9%) in our study. The cultures showed growth of gram negative *bacilli* (57.5%) hich was most common followed by gram positive *cocci* (35.9%), gram negative *coccobacilli* (3.8%) and gram negative cocci (2.6%). Elmanama et al. [34], in their study found a similar trend with gram-negative bacteria being the predominant isolates (58.3%) when compared to gram-positive bacteria (39.2%). This is in agreement with previous studies done in South Korea, Ethiopia, Nigeria, Greece, Pakistan, Turkey and Eastern Nepal [13, 35–42].

Psedudomonas aeruginosa were found in the majority of samples (27.1%) followed by *Staphylococcus aureus* (23.3%) in our study. Other bacteria that were isolated included Proteus mirabilis, *Enterococcus spp.* and *Proteus vulgaris*. In accordance with our study, Sharma et al. [42], in eastern Nepal, found a predominance of *Pseudomonas aeruginosa* (36.4%), followed by *Staphylococcus aureus* (30.2%) from a total of 322 aural swab cultures, while in contrast, Fairbanks [3] reported the isolation of 10% *Pseudomonas* and 22% *Staphylococcus aureus* strains in their study. Similar conclusion was drawn by Indudharan et al. [43] who found *Pseudomonas* as the most common organism in CSOM. Similar findings have been observed in Greece, Ireland and Pakistan who reported that *P. aeruginosa* and *S. aureus* are the most common organisms isolated from the cases of otitis media [39, 44, 45]. In contrast Taneja et al. (33.3%), Prakash et al. (41.25%), Rao et al. (42.5%) and Singh et al. (36%) [24, 46–48] found *Staphylococcus aureus* as the dominant pathogen in their studies.

In our study, the most common bacteria isolated in both adult and paediatric age groups were *Pseudomonas aeruginosa*. Similar results are observed in numerous studies done from time to time. In various studies conducted by Malkappa et al. (45.2%), Saraswati et al. (60%), Arvind, et al. (41.5%), Gaur et al. (30.96%) and Shetty and Shetty (82.5%) [23, 26, 49–51] revealed *Pseudomonas aeruginosa* to be the dominant bacteria in their respective studies. The increased rate of isolation of *Pseudomonas aeruginosa* in our study has its own implications, as this organism is an important cause of nosocomial infections and has developed resistance to even many potent antibiotics. *Pseudomonas* infections are mostly seen where there is discontinuity of normal skin or when normal flora is replaced by it due to constant use of topical antibiotics. The easy availability of over the counter topical antibiotic drops and their rampant use breeds an environment where organisms like *Pseudomonas* can grow and develop resistance to even many potent antibiotics [9, 26].

Staphylococcus aureus was found to be the most common bacteria in many studies done by various authors like Agrawal et al., Ahmad et al. and Ayson et al. [20, 27, 52], whereas, we found it to be second most common organism after *Pseudomonas aeruginosa*. Staphylococcus is found as a commensal in the skin and respiratory tract and this difference in finding can be attributed to the difference in environmental and climatic conditions.

Sensitivity Pattern

Among the tested antibiotics, polymyxin B (100.0%) was the most effective antibiotic in both paediatric as well as adult population for *Pseudomonas aeruginosa*. It is followed by ciprofloxacin (46.4%), neomycin (42.9%) and gentamicin (42.9%). Hundred percent of both adult and paediatric samples showed sensitivity to polymyxin B. Pseudomonas was found to be most resistant to methicillin in 100% cases followed by cefixime in 92.5%, erythromycin in 92.5%, co-amoxyclav in 82.1%, cotrimoxazole in 75.0%, chloramphenicol in 75.0%, ofloxacin in 75.0%, neomycin in 57.1% and gentamicin in 57.1%.

Antibiotic sensitivity of all cultured bacteria was done and it was found that *Pseudomonas* was sensitive to polymyxin B (100%) followed by ciprofloxacin (46.4%), neomycin (42.9%) and gentamicin (42.9%). These results are in correspondence to studies of Agrawal et al. and Shetty et al. [20, 51]. This is in contrast to other studies where *Pseudomonas* was found to show high sensitivity to flouroquinolones like Malkappa et al. (76%) and Saraswati et al. (76%) [23, 26]. The decrease in sensitivity to quinolones can be explained by the fact that there is injudicious use of antibiotics at the primary health care level. *Staphylococcus aureus* showed high sensitivity to methicillin (100.0%), gentamicin (95.8%), co-amoxyclav (95.8%), chloramphenicol (87.5%), polymyxin B (75.0%) and ofloxacin (75.0%) in the decreasing order. It was found to be resistant to cefixime in 58.3% cases and to neomycin in 50% of cases. Higher sensitivity (75%- 95%) was observed with cefuroxime (76.6%), piperacillin/tazobactam (78.7%), doxycycline (85.1%), amikacin (89.4%), and moxifloxacin (93.6%). It showed 38.3% sensitivity with ampicillin, 55.3% with ciprofloxacin, and 61.7% with macrolides according to Agrarwal [20]. It was observed that *Pseudomonas* and *Staphylococcus* isolates showed high resistance against amoxicillin–clavulanic acid and

cefixime. Malkappa et al. [23] found that 90% of their culture isolates were resistant to amoxicillin.

Most of the gram negative bacteria were found to be sensitive to polymyxin B and gentamicin which are readily available as topical forms. Gram positive bacteria were found to be highly sensitive to methicillin and co-amoxyclav followed by ciprofloxacin. It is also seen in some previous studies. This result will help in more cost effective treatment in this part of the country.

Conclusion

Wide spectrums of bacteria were isolated from the discharging ears of atticoantral type of chronic suppurative otitis media. The most common pathologic organism was found to be *Pseudomonas aeruginosa* followed by *Staphylococcus aureus*. Other bacteria isolated were *Proteus mirabilis*, *Proteus vulgaris*, *Klebsiella pneumoniae*, *E.coli* and other *Enterococci*.

Polymyxin B is the most effective antibiotic against the cultured bacteria followed by ciprofloxacin (46.4%), neomycin (42.9%) and gentamicin (42.9%). Amoxicillin–clavulanic acid showed high resistance in case of *Pseudomonas* and high sensitivity in case of *Staphylococcus aureus*.

The paediatric and adult population showed similar bacteriological profile and no significant difference was observed.

The knowledge of prevalent bacteria in the local population and their antibiograms will help the treating ENT surgeon to effectively treat the atticoantral type of CSOM and prevent emergence of drug resistant bacteria.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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