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Original Research

Correlation of Sensorineural Hearing Loss with Age, Disease Duration, and Cholesteatoma in Chronic Otitis Media

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Abstract

Introduction: Otitis media (OM) is an infection or inflammation of the middle ear, which can be acute (AOM), with fluid (OME), or chronic (CSOM). CSOM is common in India and can cause hearing loss. Risk factors include infections, Eustachian tube problems, poor hygiene, and low socioeconomic conditions. ***Materials and Methods:*** This study was conducted at GSVM Medical College, Kanpur, from December 2008 to June 2010. A total of 64 patients with chronic otitis media and hearing problems were included. Patients with head injury, ear surgery, meningitis, systemic illnesses affecting hearing, or hereditary hearing loss were excluded. All patients had a detailed ear examination, hearing tests (audiometry), and X-ray of the mastoid. Hearing loss was classified as conductive, sensorineural, or mixed. Data were analysed using standard statistics. ***Results:*** Most patients were 11-20 years old (56%), with more males (56%) than females (44%). Disease duration was usually less than 5 years (77%). Ear discharge was mostly mucopurulent (63%), and 23% had foul-smelling discharge. The most common bacteria found was Pseudomonas aeruginosa (38%). Radiology showed half had normal mastoid air cells. Tubotympanic disease was more common (63%) than atticoantral (37%). Cholesteatoma was present in 27% and was mostly seen in atticoantral disease. Hearing loss was mainly conductive (56%), followed by mixed (28%) and sensorineural (16%). Sensorineural loss was linked to older age and longer disease duration, while mixed loss was common in patients with cholesteatoma. ***Conclusion:*** Chronic otitis media affects mostly adolescents and young adults and often leads to hearing loss. Cholesteatoma is linked with more severe disease and mixed hearing loss. Early diagnosis, proper treatment, and hearing assessment are important to prevent permanent hearing damage.

Keywords: *Otitis media, CSOM, Hearing loss, Cholesteatoma, Audiometry*

Introduction

Otitis media (OM) denotes a group of inflammatory and/or infective diseases of the middle ear, typically involving the middle -ear space behind the tympanic membrane. [1, 2] OM encompasses a spectrum of conditions that vary in onset, duration, and the presence or absence of active infection. [3, 4]. The main recognized types of Otitis media are Acute otitis media (AOM), Otitis media with effusion (OME), and Chronic suppurative otitis media (CSOM). [1, 5] AOM refers to a rapid-onset middle-ear infection, usually symptomatic with ear pain or fever. [6] OME is characterized by non-infective fluid accumulation in the middle ear (effusion) without the signs of acute inflammation – often occurring after an AOM episode. [7] CSOM denotes a long-term disease with persistent or recurrent ear discharge (suppuration) via a perforated tympanic membrane, typically lasting weeks or more. [6] Otitis media comprises a significant public health burden in India. A large meta-analysis of community-based studies in Indian children estimated pooled prevalences of CSOM at 3.78% (95% CI 2.72-4.84), OME at 2.68% (95% CI 1.80-3.55), and AOM at 0.55% (95% CI 0.32-0.78). [8] These findings reflect substantial ear-disease prevalence in childhood, though the authors note that due to heterogeneity and limited data, the true burden is likely under-recognized. [8] In earlier localized studies, prevalence of CSOM in rural South Indian children (ages 2-10 years) was reported around 6% in one survey. [9] Another study in Aligarh among primary school children found CSOM prevalence of ~6.1%, with higher rates in rural than urban populations. [10] OM arises from a mix of infectious, anatomical, immunological, environmental and socioeconomic factors. [11] [12] The most common infective pathogens in AOM include bacteria such as Streptococcus pneumoniae, Haemophilus influenzae (non-typable), and Moraxella catarrhalis; viral upper respiratory tract infections (URTIs) often precede or accompany these bacterial infections. [6] Predisposing non-infectious factors include Eustachian tube dysfunction (common in children due to anatomical immaturity), craniofacial abnormalities, impaired immunity (e.g. immunodeficiency, malnutrition), and environmental exposures. [11, 12] In India, additional socioeconomic and environmental risk factors frequently associated with OM and particularly CSOM include passive smoking, poor hygiene, indoor cooking with biomass/kerosene fuel, recurrent URTI, overcrowding, low socioeconomic status, bottle feeding, lack of adequate healthcare, and delayed or absent treatment of initial ear infections. [13, 14, 15] Clinical manifestations depend on the type of Otitis media. In Acute Otitis media, common symptoms include ear pain (otalgia), fever, irritability especially in children, sometimes systemic signs like nausea or vomiting, and reduced hearing during the illness. [6].

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OME may be asymptomatic or present as a sensation of ear fullness and hearing impairment due to fluid behind an intact eardrum. [7] In CSOM, the hallmark is persistent or recurrent discharge (otorrhea) through a perforated tympanic membrane, often with hearing loss; but ear pain may be minimal or absent. [6] Diagnosis relies primarily on clinical history and physical examination of the ear including otoscopy (visualization of tympanic membrane). [7]Additional diagnostic tools may include pneumatic otoscopy (to assess eardrum mobili ty), tympanometry (to detect middle-ear fluid), acoustic reflectometry, and audiometry (hearing test), especially if hearing impairment is suspected or for chronic cases. [1] In complicated or chronic cases imaging (e.g. CT/MRI) might be needed to evaluate mastoid or intrac ranial complications, although such measures are less common in routine cases. [1] Management of OM depends on the type and severity. For AOM, symptomatic relief with analgesics (painkillers) and antipyretics is often first-line; antibiotics are reserved for bacterial infections, severe or persistent cases, or where complications are likely. [6] Since many AOM episodes resolve spontaneously, judicious use of antibiotics is important. [1] For Otitis media, watchful waiting may be adopted if there are no significant symptoms; persistent effusion affecting hearing or development may require further intervention. [7] In CSOM, management includes thorough cleaning of the ear canal, removal of granulation tissue if present, application of topical antibiotics (and sometimes corticosteroids), with systemic antibiotics or surgical intervention (e.g. tympanoplasty, mastoid surgery) reserved for severe or refractory cases. [5, 6] Hearing evaluation and rehabilitation may als o be necessary if there is hearing loss. [16] OM, particularly CSOM, remains a significant cause of preventable hearing loss in children in India and other developing countries. [8, 9] Due to heterogeneity of studies, under-reporting, lack of regular epidemiological surveillance, and socioeconomic/environmental barriers, the true burden of OM may be underestimated in India. [8] The presence of risk factors such as passive smoking, poor hygiene, indoor pollution, limited awareness, and inadequate access to trained ENT care contribute to persistence, recurrence, and chronicity. [14, 15] Effective strategies for prevention, early diagnosis, appropriate treatment, and education are needed to reduce the burden, prevent hearing loss, and improve long-term

Materials and Methods

The present study was conducted in the Department of Otorhinolaryngology, GSVM Medical College and the associated L.L.R. Hospital from December 2008 to June 2010. A total of 64 patients were enrolled after applying the predefined exclusion criteria, and all presented to the ENT outpatient department with audio-vestibular complaints, while several required hospital admission in the inpatient ward of the department. All cases were clinically diagnosed as having chronic otitis media associated with hearing impairment. Patients with a history of head injury, previous ear surgeries involving bone drilling, a history of meningitis, systemic illnesses known to affect hearing, intake of ototoxic medications, and hereditary hearing loss were excluded as per the protocol to avoid confounding factors.

The study population included both male and female patients across a wide age distribution, with the majority originating from Kanpur and nearby areas. Each patient underwent detailed clinical evaluation and a comprehensive audiological assessment using a structured proforma. Detailed clinical history including symptoms, past history, personal habits, and family history was recorded. Particular attention was given to possible associations of age, sex, socioeconomic status, nutritional status, family history and environmental exposure with the disease condition, because these determinants are recognised contributors to chronic otitis media and related hearing disorders. A complete otolaryngological examination was performed in every case with emphasis on audiological findings, followed by general systemi c evaluation. All patients were subjected to audiometric testing, including pure-tone audiometry and impedance audiometry. Air and bone conduction thresholds were measured in a sound-treated room using the standard threshold technique based on multiple crossing criteria, commonly described as the “5-up and 10-down” approach or the Hughson-Westlake method, through which the threshold was confirmed only when at least three out of five responses were positive. During bone conduction testing, masking of the contralateral ear was performed in all subjects. For air conduction testing, narrowband masking of the non-test ear was applied whenever the interaural air-conduction threshold difference equalled or exceeded 40 dB, to avoid cross-hearing artefacts.

Audiometric frequencies evaluated for air conduction included 250, 500, 1000, 2000, 4000, 6000 and 8000 Hz, and the same frequencies were assessed for bone conduction. In each case, the ear with better hearing was tested first. Hearing loss was quantified by calc ulating the pure-tone average (PTA), defined as the average of thresholds at 500, 1000 and 2000 Hz, consistent with standard clinical audiology practice. For patients with sensorineural hearing loss, bone conduction thresholds were used for PTA calculation, whereas in conductive or mixed losses, air-conduction thresholds were utilised, following accepted audiological recommendations. This method reflects current international audiology standards in the assessment and classification of hearing impairment.

Normal	<25 dB
Mild Hearing Impairment	26 - 40 dB
Moderate Impairment	41 - 60 dB
Severe Impairment	71 - 90 dB
Profound	>90 dB

The air-bone gap was calculated when the bone-conduction threshold exceeded 20 dB hearing level. When the air-bone gap measured 15 dB or less, the hearing loss was considered to be of sensorineural type. However, if the bone-conduction threshold was greater than 20 dB and the air-bone gap was 20 dB or more, the hearing impairment was classified as mixed.

Statistical Analysis

All collected data were entered into a Microsoft Excel spreadsheet and subsequently analysed using standard statistical software. Descriptive statistics were used to summarize demographic variables such as age, sex, and residence. Continuous variables (such as pure tone thresholds and air-bone gaps) were expressed as mean ± standard deviation, whereas categorical var iables were presented as frequencies and percentages.

For comparison of hearing thresholds between the affected and contralateral ears, paired t-tests were performed, provided normal distribution assumptions were met. In cases where data did not follow normal distribution, non-parametric tests such as the Wilcoxon signed-rank test were applied. The degree and type of hearing loss (conductive, sensorineural, or mixed) were compared across different demographic subgroups (age, sex, and urban–rural background) using Chi-square test or Fisher’s exact test wherever appropriate.

Correlation analyses were performed to examine the relationship between clinical parameters (duration of otitis media, presence of discharge, Eustachian dysfunction, etc.) and severity of hearing loss, using Pearson or Spearman correlation coefficients depending on normality of distribution. For all analyses, a p-value of <0.05 was considered statistically significant. Confidence intervals (95% CI) were calculated wherever applicable

Results

The present study was undertaken on patients who either attended the outpatient services or were admitted for management and surgical intervention for unilateral ear disease in the Department of Otorhinolaryngology, G.S.V.M. Medical College, Kanpur. The study population therefore included both ambulatory patients with chronic otological complaints as well as inpatients requiring operative proc edures related to middle-ear pathology. All participants were evaluated during the study period extending from Decem ber 2008 to June 2010, allowing adequate representation of cases across this duration and ensuring uniformity in diagnostic and therapeutic assessment.

Table 1: Demographic Characteristics of the Study Subjects by Age and Sex

Age Group	Male	Female	Total	Percentage
<10	1	5	6	9.38%
11 - 20	24	12	36	56.25%
21 - 30	6	5	11	17.19%
31 - 40	2	4	6	9.38%
41 - 50	2	1	3	4.69%
21 - 60	1	0	1	1.56%
> 60	0	1	1	1.56%

Table 2: Gender Distribution of the Study Population

Gender	Number of Patients	Percentage
Male	36	56.25%
Female	28	43.75%

Table 3: Duration of Disease Among Patients Included in the Study

Duration in Years	Number of Patients	Percentage
<5	49	76.58
6 - 10	5	7.81
11 - 15	2	3.12
16 - 20	5	7.81
>20	3	4.68

Table 4 : Clinical Distribution of Nasal Discharge Types Among the Study Population

Type of Discharge	Number of Patients	Percentage
Mucoid	21	32.81
Mucopurulent	40	62.5
Blood Stained	3	4.68

Table 5: Distribution of Patients According to Odour Characteristics of Nasal Discharge

Odour	No of patients	Percentage
Odourless	49	76.58%
Foul Smelling	15	23.44%
Culture	No of patients	Percentage
Positive	40	62.5%
Negative	24	37.5%

Table 6 Distribution of Isolated Microorganisms Among Culture-Positive Patients

Microorganism	No of Patients	Percentage
Pseudomonas Aeruginosa	15	37.5%
Streptococcus	6	15%
Klebsiella Pneumoniae	2	5%
Haemophilus Influenza	7	17.5%
Others	10	25%

Table7 : Distribution of Chief Clinical Complaints Among Study Participants

Chief Complaint	No of patients	Percentage
Otalgia	13	20.31%
Subjective Hearing Loss	48	75%
Tinnitus	3	4.68%

Table 8 Radiological Pattern of Mastoid Air Cell System on X-ray Schüller View

X- rays mastoid Schuller view	No of patients	Percentage
Diploeic	9	14.05%
Pneumatic	32	50.00%
Sclerotic	23	35.94%

Table 9: Additional Radiological Findings Observed on Mastoid X-ray

Other finding on X - rays	Number of Patients	Percentage
Erosion of dural plate / sinus plate	3	4.3
Lytic erosion / scutum erosion	2	2.7

Table 10: Distribution of Disease Type According to Gender

Type of Disease	Male	Female	Total	Percentage	
Anticoantral	14	10	24	37.5%	$X^2 = 4.00$
Tubotympanic	23	17	40	62.5%	P value < 0.05

Table 11: Prevalence of Cholesteatoma Among the Study Population

Cholesteatoma	No of patients	Percentage
Present	17	26.56%
Absent	47	73.43%

Table12 : Association of Cholesteatoma with Atticoantral Disease

Cholesteatoma	No of patients with Atticoantral Disease	Percentage	
Present	17	77.27%	$X^2 = 4.16$
Absent	7	31.82%	P value = ,0.05

Table 13 : Distribution of Types of Hearing Loss among the Study Population

Hearing loss	No of patients	Percentage	
Conductive	36	56.25	$X^2 = 16.62$ P value = 0.001
Mixed	18	28.12	
Sensorineural	10	15.82	

Table 14 Age-wise Distribution of Sensorineural Hearing Loss Among the Study Population"

Age of patients in years	Total number of patients in the groups	No of patients with sensorineural Hearing loss	Percentage	
6 - 10	6	0	0	$X^2 = 34.37$ P value = 0.001
11 - 19	36	4	11.11	
20 - 29	11	2	18.18	
>30	11	4	36.36	

Table 15: Association Between Duration of Disease and Incidence of Sensorineural Hearing Loss

Duration of disease (in years	No of cases	Incidence of sensorineural hearing loss	Percentage	
0 - 10	49	6	14.06	$X^2 = 18.06$ P value = 0.001
11 - 20	12	3	25	
>21	3	1	33.33	

Table 16: Association of Hearing Loss Type with Presence of Cholesteatoma

Type of hearing loss	Number of patients with cholesteatoma	Percentage	
Sensorineural	4	23.53%	$X^2 = 18.06$ P value = 0.001
Conductive	4	23.53%	
Mixed	9	52.94%	

Discussion

In this study of 64 patients with unilateral ear disease, the age distribution showed a clear concentration in adolescence and early adulthood: 36 patients (56.25%) were in the 11-20 year age group, 11 patients (17.19%) were 21-30 years, 6 patients (9.38%) were <10 years, 6 patients (9.38%) were 31-40 years, 3 patients (4.69%) were 41-50 years, 1 patient (1.56%) was between 51-60 years, and 1 patient (1.56%) was >60 years. There was a mild male predominance with 36 males (56.25%) and 28 females (43.75%), wh ich may reflect either true sex differences in disease incidence or variation in health-seeking behavior.

Regarding duration of disease, the majority of patients (49/64; 76.58%) had symptoms for less than five years; 5 patients (7.81%) had disease for 6-10 years, 5 patients (7.81%) had disease for 16-20 years, 2 patients (3.12%) for 11-15 years, and 3 patients (4.68%) reported duration >20 years. The predominance of shorter durations suggests many presentations occurred within the early chronic phase, though a nontrivial minority had long-standing disease.

Clinical characteristics of the discharge revealed mucopurulent otorrhoea to be the most frequent type, occurring in 40 patients (62.5%), while 21 patients (32.81%) had mucoid discharge and 3 patients (4.68%) had blood-stained discharge. Odour characteristics showed most discharges were odourless (49/64; 76.58%), while 15 patients (23.44%) reported foul-smelling discharge. Microbiological culture was positive in 40 patients (62.5%) and negative in 24 patients (37.5%). Among culture-positive isolates, Pseudomonas aeruginosa was the commonest organism (15/40 culture-positive patients; 37.5%), followed by Haemophilus influenzae in 7 patients (17.5%), Streptococcus species in 6 patients (15%), Klebsiella pneumoniae in 2 patients (5%), and other organisms accounting for 10 isolates (25%). The predomina nce of Pseudomonas and other gram-negative organisms is concordant with typical microbiologic profiles of chronic suppurative ear discharge and bears on empirical antibiotic selection.

Subjective hearing loss was the dominant presenting complaint, reported by 48 patients (75%), while otalgia was present in 13 patients (20.31%) and tinnitus in 3 patients (4.68%). Radiological evaluation on mastoid Schüller view demonstrated a pneumatic mastoi d pattern in 32 patients (50.00%), sclerotic mastoid in 23 patients (35.94%), and diploëic pattern in 9 patients (14.05%). Additional radiographic findings of bony erosion were uncommon: erosion of the dural/sinus plate was seen in 3 patients (4.3%) and lytic/scutum erosion in 2 patients (2.7%). When disease types were analysed by gender and overall distribution, tubotympanic disease was more common, occurring in 40 patients (62.5%), versus atticoantral disease in 24 patients (37.5%). The difference by gender reached statistical indication of assoc iation ($X^2 = 4.00$, $P < 0.05$), with atticoantral disease present in 14 males and 10 females and tubotympanic disease in 23 males and 17 females. Cholesteatoma was present in 17 patients (26.56%) and absent in 47 (73.43%). Among patients with atticoantral disease, 17/22 (77.27%) had cholesteatoma compared with 7/22 (31.82%) among the non-atticoantral group (reported $X^2 = 4.16$, $P \approx 0.05$), indicating a strong link between atticoantral pathology and cholesteatoma formation.

Audiometric patterns showed that conductive hearing loss was the most frequent type, present in 36 patients (56.25%), while mixed hearing loss occurred in 18 patients (28.12%) and sensorineural hearing loss (SNHL) in 10 patients (15.63%). The distribution of hearing loss types was statistically significant ($X^2 = 16.62$, $P = 0.001$), reflecting that while conductive loss predominates in middle ear disease, a substantial minority have cochlear involvement or mixed pathology. Age-wise, SNHL was absent in the youngest group (6-10 years: 0/6; 0%), occurred in 4/36 patients aged 11-19 (11.11%), in 2/11 patients aged 20-29 (18.18%), and in 4/11 patients aged >30 (36.36%); this age-wise distribution of SNHL was significant ($X^2 = 34.37$, $P = 0.001$), showing an increasing prevalence of cochlear impairment with advancing age.

Duration of disease was also associated with SNHL: among those with disease duration 0-10 years, 6/49 (14.06%) had SNHL; among those with 11-20 years, 3/12 (25%) had SNHL; and among those with >21 years, 1/3 (33.33%) had SNHL (reported $X^2 = 18.06$, $P = 0.001$). This trend supports a cumulative effect of chronic middle ear inflammation on inner-ear function over time. Finally, when hearing loss type was examined in relation to cholesteatoma, among patients with cholesteatoma the distribution was: sensorineural loss in 4 patients (23.53%), conductive loss in 4 patients (23.53%), and mixed loss in 9 patients (52.94%) (reported $X^2 = 18.06$, $P = 0.001$), indicating that cholesteatomatous disease is more frequently associated with mixed (combined conductive and sensorineural) impairment th an pure conductive or pure sensorineural losses.

Taken together, these results indicate that while tubotympanic (safer) disease and conductive hearing loss predominate in this cohort, there is a clinically meaningful burden of atticoantral disease, cholesteatoma (26.6%), and both mixed and sensorineural hearing loss. Increasing age and longer disease duration are clearly associated with higher rates of SNHL, and cholesteatoma appears to predispose to mixed hearing

loss. The microbiological profile dominated by Pseudomonas aeruginosa (15/40 culture-positive patients; 37.5%) underscores the need for appropriate culture-guided therapy. Clinically, these findings emphasize early diagnosis, regular audiometric monitoring (including bone-conduction thresholds), targeted antimicrobial therapy based on culture results, and timely surgical management of unsafe disease and cholesteatoma to reduce the risk of progressive cochlear damage and long-term auditory morbidity.

de Azevedo AF et al., (2007) [16] The mean age of patients was 26.3 years. There were 58 males and 57 females. The average duration of disease was 12.4 years. The mean hearing threshold was 40 dB in the CSOM ear compared to 22 dB in the normal ear (P = 0.002). Cholesteatoma was present in 78 out of 115 cases. Sensorineural hearing loss (SNHL) was found in 15 cases, including 6 with profound loss. SNHL showed a significant association with older age (P = 0.003), but not with disease duration (P = 0.458) or the presence of cholesteatoma (P = 0.01). Overall, SNHL occurred in 13% of patients with CSOM.

Shetty KC et al. (2019) [17] There was a significant relationship between the type of disease and the type of perforation with the degree of hearing loss. There was also a clear difference in hearing between the two ears at speech frequencies. Sensorineural hearing loss was found in 19.1% of the patients. Sensorineural hearing loss occurs in many patients with chronic otitis media, and it was more common in those with squamosal disease. The type of disease and the type of perforation were both significantly related to the amount of hearing loss.

Wahyudiono AD et al., (2024) [18] The study included 42 patients with chronic suppurative otitis media, comprising 14 men and 28 women. The mean duration of ear discharge was 95 ± 84.4 months. The average air conduction hearing threshold in the CSOM affected ears was 53.7 ± 16.8 dB, while the contralateral normal ears had a mean threshold of 25.8 ± 12.5 dB. The mean Middle Ear Risk Index (MERI) score for the CSOM ears was 6.4, ranging from 1 to 13. In ears with cholesteatoma, there was a strong positive correlation between the MERI score and hearing threshold in the contralateral ear ($r = 0.610$, $P < 0.01$). In non cholesteatomatous ears, a weaker but significant positive correlation was also observed ($r = 0.384$, $P < 0.05$). These findings indicate that more severe middle ear disease, as reflected by higher MERI scores, was associated with worse hearing in the contralateral “normal” ear.

Conclusion

Chronic ear disease mostly affects young people, especially those aged 11-20 years, and slightly more males. Most patients had the disease for less than five years. The main symptom was hearing loss, and most had pus-like (mucopurulent) ear discharge. Pseudomonas aeruginosa was the most common bacteria found. X-rays showed that half had normal mastoids, while some had changes or bone erosion. Tubotympanic disease was more common than atticoantral disease. Cholesteatoma was seen in about one-fourth of patients, mainly with atticoantral disease. Conductive hearing loss was most common, but mixed and sensorineural hearing loss occurred in some, especially older patients or those with longer disease. Early diagnosis and treatment are important to prevent hearing loss and complications.

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