



## **Clinical and Audiological Characteristics of Chronic Suppurative Otitis Media in Al Muthanna Province Patients**

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### **Abstract**

**Background:** Chronic suppurative otitis media (CSOM) is an ongoing inflammatory disorder of the middle ear characterized by recurrent or ongoing ear drainage through a perforated tympanic membrane. This disease is still a major public health problem in many developing countries, including Iraq. In Iraq, CSOM usually accompanies hearing loss and serious complications in the brain. Although CSOM is common in Iraq, there are very limited clinical and audiological data regarding patients afflicted by this disease in the current literature.

**Objectives:** This study aimed to explore the demographic, clinical, and audiological profiles of patients with CSOM who were seen at a tertiary referral hospital in southern Iraq. In addition, the study aimed to examine associations among different types of CSOM, duration of the disease, and hearing loss.

**Methods:** This prospective cross-sectional study was performed at the Ear, Nose, and Throat (ENT) outpatient department located within Al-Hussein Teaching Hospital in Samawa, Al-Muthanna Governorate, Iraq, from January 2020 through December 2022. A total of two-hundred fourteen subjects who met the diagnosis of CSOM were included in this study. Clinical evaluations, otoscopic examinations, microbiological culture of swabs, and audiometry testing were conducted on each subject. Data was analyzed via SPSS software version 26.

**Results:** The sample size included two-hundred fourteen patients (118 males, 96 females; mean age  $28.4 \pm 12.7$  years). Incidence of CSOM was as follows: tubotympanic (safe) 147 patients (68.7%) and atticoantral (unsafe) 67 patients (31.3%). 38.3% of all subjects had bilateral disease. Otorrhea was the most frequently reported sign (100%) followed by hearing loss (87.4%) and otalgia (42.1%). The most common microorganism isolated on culture was *Staphylococcus aureus* (34.6%), followed by *Pseudomonas aeruginosa* (28.0%). Auditory testing indicated that the predominant type of hearing loss was conductive; the mean air-bone gap (ABG) for tubotympanic patients was  $32.4 \pm 9.8$  dB and for atticoantral patients was  $41.7 \pm 11.2$  dB ( $p < 0.001$ ). Large central tympanic membrane perforations correlated with significant increases in hearing threshold levels.

**Conclusion:** The demographic and audiological profile of this sample of Iraqis with CSOM suggests that the disease is primarily present in young adult patients, most frequently as the tubotympanic type, and with a significant degree of conductive hearing loss. In addition, there are increased degrees of auditory impairment associated with the atticoantral form of CSOM than with the tubotympanic form. Early diagnosis, treatment directed at the underlying infection, and timely surgical intervention are essential to prevent additional auditory impairment in this population.

**Keywords:**

*Chronic suppurative otitis media; CSOM; audiological characteristics; hearing loss; otorrhoea; tympanic membrane perforation; Iraq; pure-tone audiometry; Pseudomonas aeruginosa; Staphylococcus aureus.*

**1. INTRODUCTION**

Chronic suppurative otitis media (CSOM) is defined as having an ongoing infection and inflammation affecting the bone and lining of the middle ear. The condition is considered to be caused by a previous bacterial infection that results in an ongoing discharge through an underlying perforation in the tympanic membrane for at least two to six weeks [1,2]. CSOM is the most commonly diagnosed infectious condition of the ear across the world and is highly concentrated in low-income and middle-income countries, particularly in areas of high population density, malnutrition, little access to healthcare, and poor sanitary conditions [3,4]. In Iraq, where the country has suffered from a lengthy period of economic instability and deterioration to its healthcare system, CSOM continues to be highly prevalent compared to developed countries [5].

Globally, the World Health Organization (WHO) estimates that there are approximately 330 million people with CSOM, with more than 90% of reported cases occurring in developing countries [6]. In the Eastern Mediterranean region, which includes Iraq, the prevalence of CSOM in school-aged children is estimated to range from 2% to 6%, with higher rates reported in some rural and conflict-affected areas [7,8]. Based on the behaviour of the symptoms and associated pathology of the condition, there are two major subtypes that can be identified. These are the tubotympanic or safe or mucosal type which has central perforations in the tympanic membrane, the other is the atticotympanic, unsafe or squamous type, which has perforations either at the edges or in the attic of the tympanic membrane and can lead to the formation of cholesteatoma. A cholesteatoma is a destructive cyst that can damage the ossicular chain and the bone surrounding the ear [9,10].

There are numerous and significant audiological implications as a result of CSOM. One of the major audiological sequela of CSOM is conductive hearing loss due to interruption of the transmission of sound as it travels through the tympanic membrane and the ossicles [11,12]. Severity of the conductive loss is affected by perforation size and location, ossicular discontinuity or fixation, and presence of cholesteatoma, and chronicity of the condition [13,14]. Additionally, in cases of severe or long-standing CSOM, some patients may have sensorineural components to their hearing losses. This may occur due to diffuse

bacterial toxins and inflammatory mediators passing through the round window and affecting the inner ear [15]. Particularly in children, hearing loss as a result of CSOM can have detrimental effects on language development, educational achievement and psychosocial development [16,17].

CSOM also may lead to serious and sometimes life-threatening complications beyond hearing loss. Intracranial and intratemporal complications of CSOM are as follows: mastoiditis, labyrinthitis, petrositis, and facial nerve paralysis and meningitis, lateral sinus thrombosis, subdural empyema, and brain abscess [18,19]. Resource-poor settings such as the country of

Iraq are associated with delays in presenting to the health care system and/or lack of adequate primary care, resulting in individuals with advanced or complicated conditions seeking care in tertiary health facilities [20]. In comparison to other areas of the world, the bacteriological characteristics of individuals with CSOM in Iraq differ; the predominant organisms associated with CSOM in Iraq are gram-negative aerobic bacteria, especially *Pseudomonas aeruginosa* and *Proteus mirabilis*, along with gram-positive organisms including *Staphylococcus aureus*, both of which affect how antibiotics are used as empirical therapies [21,22].

The epidemiological pattern of CSOM in Iraq has not been well described in the literature; however, a few small studies performed in the city of Baghdad and other northern Iraqi cities have provided some preliminary information [23,24]. It should be noted that, to date, there have been no studies published on the epidemiology of CSOM in Southern Iraq, including the Al-Muthanna Governorate; however, the southern region of Iraq has specific epidemiological characteristics, such as extreme weather conditions, limited availability of ENT specialists, and historically low health care utilisation rates, which may alter how CSOM manifests clinically and how much hearing loss is associated with CSOM [25]. Al-Hussein Teaching Hospital in Samawa, the capital of Al-Muthanna Governorate, is the primary tertiary referral centre for ENT disorders for a catchment area of > 800,000 people and provides an excellent venue for the conduct of representative studies of this population.

The relationship between the subtypes of CSOM, the bacteriological findings, and the audiological outcome in Iraqi patients with CSOM has yet to be studied systematically. The relationship between CSOM and various clinical factors is essential in making decisions based on the timing and type of surgical interventions required to treat patients with CSOM, choosing the appropriate antimicrobials used to treat patients with CSOM, and prioritising the audiological rehabilitation needs of patients suffering from CSOM. Accurate data at the local level are required for developing health policy, particularly with regards to resource allocation for hearing screening programmes and surgical services in underserved areas [26, 27].

Pure-tone audiometry is the gold standard for assessing the degree of hearing impairment in patients with CSOM, measuring both the air-bone gap, which reflects the degree of conductive hearing loss, and the bone-conduction threshold, which indicates the presence of a sensorineural component to hearing loss [28, 29]. Other tests, such as tympanometry and impedance audiometry, provide complementary information about middle ear compliance and pressure; however, their usefulness is limited in the presence of tympanic membrane perforations [30]. The relationship between the audiometric findings from patients with CSOM and the pathological features of CSOM, such as size of the tympanic membrane perforation, ossicular status, and presence of cholesteatomas, has been investigated in different geographic regions; however, further evaluation is required in Iraq [31, 32].

The causative microorganisms causing CSOM are diverse and constantly evolving; their respective patterns of resistance vary according to geography, environment, and health care systems. The overall burden of antimicrobial resistance among the causative organisms has been increasing; therefore, the local species that cause CSOM and their patterns of resistance will be different than those reported in the international literature. Several epidemiological studies in neighbouring countries and throughout the Middle East have reported high rates of

fluoroquinolone resistance in *Pseudomonas* spp. and methicillin-resistant *Staphylococcus aureus* in patients with CSOM, representing a major challenge for clinicians who have low access to second-line therapies [35, 36].

Considering all of the above, the aim of this study was to comprehensively characterise the clinical and audiological profile of patients with CSOM presenting to Al-Hussein Teaching Hospital in Samawa, Iraq, over a two-year time period from 2020 to 2022. The specific objectives of the study were to provide demographic and clinical data for the population included in the study; classify patients with CSOM by type of CSOM and document any associated clinical characteristics; identify and document the most common microorganisms identified as the cause of CSOM and their susceptibility profiles; and quantify and compare the audiometric values (i.e., pure-tone average thresholds) among patients according to the subtype of CSOM, characteristics of the tympanic membrane perforation, and duration of CSOM. The results of this study will help further describe the clinical examination of patients with CSOM in the southern region of Iraq and support the establishment of evidence-based clinical practice guidelines for the management of CSOM.

## 2. MATERIALS AND METHODS

### 2.1 Study Design and Setting

This study was a prospective cross-sectional descriptive study that took place at the Ear, Nose, and Throat (ENT) outpatient clinic and inpatient unit of the Teaching Hospital of Al-Hussain, Samawa, in the Al-Muthanna province of Iraq. Al-Hussain Teaching Hospital is the only tertiary referral hospital in Al-Muthanna Province and the surrounding area, which means that it is the only hospital where people from the rural areas near the hospital can obtain specialist ENT services. The study was completed over a 24-month period from January 1, 2020, to December 31, 2022.

### 2.2 Ethical Considerations

Prior to commencement of patient recruitment, the Research and Ethics Committee of the Al-Muthanna Health Directorate (South of Iraq) and the Al-Hussein Teaching Hospital in Iraq reviewed and approved ethical approval for the study. The study was conducted in accordance with the principles in the Declaration of Helsinki. All adult patients and all parents/legal guardians of subjects under age 18 provided informed consent in writing. Patient confidentiality was maintained during both data collection and report phases of the study by assigning each patient a unique identification Code.

### 2.3 Study Population and Eligibility Criteria

Patients diagnosed with chronic suppurative otitis media who come to the ENT clinic during the study period were included as per inclusion criteria. The evidence of chronic suppurative otitis media was based on documented, persistent otorrhea of six weeks (or longer) duration and tympanic membrane perforation observed on otoscopic exams [1,2]. Patients had to be 5 years old or older, willing and able to provide informed consent, able to cooperate with audiological testing to be included. The following were exclusion criteria: (1) acute otitis media, or acute-on-chronic otitis media which included a fever; (2) history of prior ear surgery; (3) concurrent sensorineural hearing loss due to causes other than chronic suppurative otitis media; (4) presence of an active upper respiratory tract infection at examination; and (5)

inability or refusal to cooperate with audiometric testing. In addition, any immunocompromising conditions (e.g., poorly controlled diabetes mellitus-type 2, HIV infection, use of immunosuppressants) were excluded to reduce confounding microbiological effects associated with chronic suppurative otitis media.

#### **2.4 Clinical Assessment**

All subjects required that their assessment be carried out by a qualified Ear, Nose and Throat doctor over a standardized clinical assessment, including obtaining a complete history of the patient with respect to otorrhoea including: its duration and nature; what were the associated symptoms - hearing loss, earache, tinnitus and vertigo; when they had the first episode of acute otitis media in childhood; what were the social and environmental factors (e.g. housing); any history of upper respiratory infections; and breastfeeding history for children. Therefore, a detailed history taken by Doctor was to be recorded. The doctor would use a halogen otoscope and dream-vision operative microscopy to perform an otoscopic examination to accurately document the affected ear's (the outer ear) diagnosis; type of soft tissue structures involved; and whether or not there was a perforation of the tympanic membrane and where the perforation was located. The perforation was classified according to its location, the type of perforation, and the size of the perforation. The classification of the location refers to a perforation being either central or marginal/attic. The classification of the size of the perforation refers to having perforated less than 1/4 of the pars tensa (small), 1/4 to 1/2 (medium), or >1/2 (large). The CSOM diagnosis would be made based on either the tubotympanic (safe) or atticointural (unsafe) classification according to the following historically established clinical criteria [9,10,37]

#### **2.5 Microbiological Investigations**

Aural discharge from the middle ear was aseptically collected with sterile cotton-tipped applicator swabs and processed at the hospital microbiology laboratory within two hours after collection. All specimens were inoculated onto blood agar, MacConkey agar, and chocolate agar plates, and incubated aerobically for 24–48 hours at 37°C while using standard culture and sensitivity testing methods. Bacterial identification was performed using standard biochemical tests and by using the VITEK 2 Automated Identification System (bioMérieux, France) when available. Antibiotic susceptibility testing was performed using the Kirby-Bauer disc diffusion method as per the Clinical and Laboratory Standards Institute (CLSI) Guidelines [38]. Antibiotic susceptibility test results were reported as either sensitive, intermediate, or resistant for each antibiotic and organism combination.

#### **2.6 Audiological Evaluation**

Pure-tone Audiometry was conducted in a soundproof booth using a calibrated clinical audiometer (Interacoustics AC40) according to BSA (British Society of Audiology) standards [39]. Air conduction threshold testing included 250, 500, 1000, 2000, 4000 and 8000 Hz. The Bone conduction threshold testing consisted of 250, 500, 1000, 2000 and 4000 Hz. Masking was applied to the non-test ear where applicable. The Pure Tone Average (PTA) was calculated as an average (mean) of 500/1000/2000 Hz. Hearing loss classifications based upon the WHO (World Health Organization) classification system [40] were applied: Normal (0 - 25 dB HL), Mild (26 - 40 dB HL), Moderate (41 - 60dB HL), Moderately Severe (61 - 80 dB HL), Severe (81 - 90 dB HL), and Profound (>90 dB HL). Conductive component was assessed through Air-Bone Gap (ABG) for each frequency as well as mean of all frequencies 500/1000/2000 Hz.

## 2.7 Statistical Analysis

The data was analysed by using IBM SPSS Statistics (version 26, IBM Corporation; Armonk, New York) for both the entry of data and for data analysis. Frequencies and percentages were used to express the categorical variables. For the continuous variables, the mean and standard deviation (SD) were used for descriptive purposes. The chi-square test was used to compare the categorical variables in the different groups. The independent samples t-test was used to compare the means of normally distributed continuous variables and the Mann-Whitney U test was used for non-normally distributed continuous data. The Pearson correlation coefficient was used to assess the relationship of audiometric parameters with audiometric and clinical variables. Throughout the analysis, an alpha ( $\alpha$ ) level criterion of less than 0.05 was determined to be statistically significant.

## 3. RESULTS

### 3.1 Demographic Characteristics

A total of 214 patients with confirmed CSOM were enrolled during the study period. Table 1 presents the demographic and general clinical characteristics of the cohort.

**Table 1.** Demographic and General Clinical Characteristics of the Study Population (n = 214)

| Variable                   | n (%)       | Mean $\pm$ SD   |
|----------------------------|-------------|-----------------|
| Total patients             | 214 (100%)  | —               |
| Male                       | 118 (55.1%) | —               |
| Female                     | 96 (44.9%)  | —               |
| Age (years)                | —           | 28.4 $\pm$ 12.7 |
| Age group: $\leq 15$ years | 52 (24.3%)  | —               |
| Age group: 16–30 years     | 89 (41.6%)  | —               |
| Age group: 31–50 years     | 58 (27.1%)  | —               |
| Age group: $> 50$ years    | 15 (7.0%)   | —               |
| Disease duration (years)   | —           | 6.3 $\pm$ 4.8   |
| Bilateral disease          | 82 (38.3%)  | —               |

| Variable                   | n (%)       | Mean $\pm$ SD |
|----------------------------|-------------|---------------|
| Right ear affected         | 72 (33.6%)  | —             |
| Left ear affected          | 60 (28.0%)  | —             |
| Tubotympanic (safe) type   | 147 (68.7%) | —             |
| Atticoantral (unsafe) type | 67 (31.3%)  | —             |

### 3.2 Clinical Features and Microbiological Findings

Presenting signs/symptoms & culture results for those tested are indicated in Table 2. (All) Patients experienced otorrhea at time of testing; hearing loss and otalgia (ear pain) were second most common presenting signs/symptoms. *Staphylococcus aureus* & *Pseudomonas aeruginosa* were the most frequently isolated organisms associated with both types of chronic suppurative otitis media (CSOM).

**Table 2.** Presenting Symptoms and Microbiological Profile of CSOM Patients (n = 214)

| Parameter                     | Tubotympanic n=147 (%) | Atticoantral n=67 (%) | Total n=214 (%) |
|-------------------------------|------------------------|-----------------------|-----------------|
| Otorrhoea                     | 147 (100%)             | 67 (100%)             | 214 (100%)      |
| Hearing loss                  | 125 (85.0%)            | 62 (92.5%)            | 187 (87.4%)     |
| Otalgia                       | 55 (37.4%)             | 35 (52.2%)            | 90 (42.1%)      |
| Tinnitus                      | 48 (32.7%)             | 29 (43.3%)            | 77 (36.0%)      |
| Vertigo                       | 12 (8.2%)              | 18 (26.9%)            | 30 (14.0%)      |
| Headache                      | 8 (5.4%)               | 14 (20.9%)            | 22 (10.3%)      |
| <i>Staphylococcus aureus</i>  | 58 (39.5%)             | 16 (23.9%)            | 74 (34.6%)      |
| <i>Pseudomonas aeruginosa</i> | 36 (24.5%)             | 24 (35.8%)            | 60 (28.0%)      |
| <i>Proteus mirabilis</i>      | 20 (13.6%)             | 9 (13.4%)             | 29 (13.6%)      |

| Parameter       | Tubotympanic n=147 (%) | Atticoantral n=67 (%) | Total n=214 (%) |
|-----------------|------------------------|-----------------------|-----------------|
| Klebsiella spp. | 11 (7.5%)              | 6 (9.0%)              | 17 (7.9%)       |
| Mixed growth    | 14 (9.5%)              | 9 (13.4%)             | 23 (10.7%)      |
| No growth       | 8 (5.4%)               | 3 (4.5%)              | 11 (5.1%)       |

### 3.3 Audiological Findings

Table 3 shows audiological results classified according to CSOM sub-type & perforation size. The mean air-bone gap (ABG) values in the atticoantral group had a statistically significant difference when compared to those of the tubotympanic group ( $p < 0.001$ ) with the former being larger as well as having a higher incidence of moderate and moderately severe hearing loss. Regardless of the CSOM sub-type, patients with large perforations had the most substantial audiological impact.

**Table 3.** Audiological Characteristics by CSOM Subtype and Perforation Size

| Parameter                         | Tubotympanic (n=147) | Atticoantral (n=67) | p-value |
|-----------------------------------|----------------------|---------------------|---------|
| Mean PTA (dB HL)                  | 34.7 ± 10.2          | 46.3 ± 12.4         | < 0.001 |
| Mean Air-Bone Gap (dB)            | 32.4 ± 9.8           | 41.7 ± 11.2         | < 0.001 |
| Normal hearing ( $\leq 25$ dB)    | 19 (12.9%)           | 4 (6.0%)            | 0.134   |
| Mild HL (26–40 dB)                | 76 (51.7%)           | 22 (32.8%)          | 0.011   |
| Moderate HL (41–60 dB)            | 44 (29.9%)           | 33 (49.3%)          | 0.006   |
| Moderately severe HL ( $> 60$ dB) | 8 (5.4%)             | 8 (11.9%)           | 0.098   |
| Small perforation — mean PTA      | 26.3 ± 7.4           | —                   | —       |
| Medium perforation — mean PTA     | 33.8 ± 9.1           | —                   | —       |
| Large perforation — mean PTA      | 42.5 ± 11.6          | —                   | —       |
| Sensorineural component present   | 14 (9.5%)            | 21 (31.3%)          | < 0.001 |
| Mean BC threshold at 4000 Hz (dB) | 18.3 ± 8.7           | 26.4 ± 10.5         | 0.002   |

#### 4. DISCUSSION

This article offers an extensive audiological and clinical demonstration of CSOM in Southern Iraq including 214 patients and presents the first systematic study conducted in the Al-Muthanna Province as we know it. In addition to describing numerous epidemiological and pathophysiological characteristics of CSOM, this article additionally highlights practical aspects for managing CSOM in resource-limited settings.

The proportion of our patients with tubotympanic (68.7%) versus atticofacial (31.3%) CSOM was consistent with existing epidemiological data; therefore, the noted proportions of tubotympanic and atticofacial CSOM in the literature across the region, including studies conducted in Iraq's neighbouring countries such as Turkey and Iran, reflect that Eustachian tube dysfunction plays an important role in causing mucosal disease versus squamous epithelial migration leading to the development of cholesteatoma [9,10]. However, our patients had a greater than expected percentage of atticofacial disease (31.3%) when compared to other western studies (20-25%) likely due to the significant delay in our patients receiving CSOM treatment prior to attending tertiary care which could be related to how patients in southern Iraq historically have delayed seeking health care services due to geographic barriers, economic constraints, and underinvestment of basic healthcare in the community [20,25]. The majority of our analysis cohort was age 16–30 years old (41.6%) with a mean age of 28.4 years, which is in line with CSOM epidemiology in developing countries, where CSOM typically occurs as a childhood disease and remains uncured until adulthood [3,4,7]. The 24.3% of our study sample comprised children under 16 years old indicating that there is a medical need to implement child-specific early detection procedures given the well-defined negative effects of hearing loss on language development, academic success, and the psychosocial development of children [16,17]. Males were slightly more common than females in our study (55.1% vs 44.9%), which is consistent with other studies conducted in Iraq and the region, and has been attributed to a combination of them having a greater likelihood of engaging in outdoor activities/swimming and less likely to seek medical care in rural populations as a result of gender-based differences in parental health-seeking behavior [23,24].

The cohort all included patients with otorrhoea, which makes sense as having chronic discharging ears is required for a CSOM diagnosis. Hearing loss was the most commonly presented complaint in the study cohort (87.4%), demonstrating that hearing loss is the most common form of functional impairment among those affected by CSOM and the primary determinant for seeking healthcare. There is a significantly higher percentage of vertigo (26.9 vs. 8.2%) and headache (20.9% versus 5.4%) among patients with an atticofacial disease compared to patients with tubotympanic disease, which is likely due to having a more intensely destructive illness (cholesteatoma) and also the fact that cholesteatoma can invade many different structures (the bony labyrinth, semicircular canals, dura) [18,19]. This clearly demonstrates the need for much earlier identification of atticofacial disease to reduce the risk of labyrinthitis and other intracranial. At least half of the cohort in this study had *Staphylococcus aureus* (34.6%) as the bacteriological profile. Other prominent organisms included *Pseudomonas aeruginosa* (28.0%), *Proteus mirabilis* (13.6%), and *Klebsiella* sp. (7.9%). This distribution is compatible with findings in the literature from similar studies conducted within Iraq and the greater Middle East [21],[22]. The high rate of *Staphylococcus aureus* in the tubotympanic group reflects the ability of this organism to colonise chronically inflamed

mucosa and produce biofilms resistant to traditional topical therapies with antibiotics [33] whereas *Pseudomonas aeruginosa*, which was considerably more dominant within the atticoantral group (35.8%), produces virulence factors (proteases, pyocyanin) known to destroy mucosa and bone, and is intrinsically resistant to multiple classes of antibiotics [34],[35]. In 10.7% of cases, a polymicrobial infection was identified by mixed growth patterns, thereby rendering microbiological diagnosis and therapeutic decision-making challenging. The 5.1% no-growth rate is likely attributable not just to pre-existing treatment with antibiotics but also the previously described difficulties caused by anaerobic organisms in standard aerobic cultures or problems relating to the transport of specimens.

The audiological findings of this study indicate that patients with both CSOM subtypes experience significant degrees of conductive hearing loss; however, patients within the atticoantral group seemed to suffer a larger overall audiological burden than their tubotympanic counterparts. The average pure-tone threshold within the atticoantral group, ( $46.3 \pm 12.4$  dB HL), which corresponds with an overall classification of moderate severity to hearing impairment as established by WHO [40], was lower than the tubotympanic group ( $34.7 \pm 10.2$  dB HL). According to a comparative study conducted in Egypt, Saudi Arabia, and Turkey, the mean air-bone gap was being investigated in patients with cholesteatoma in their atticoantral and tubotympanic group, where there was a statistically significant difference ( $p < 0.001$ ) between groups (atticoantral =  $41.7 \text{ dB} \pm 11.2$  and tubotympanic =  $32.4 \text{ dB} \pm 9.8$ ).

A comparison of the size of the perforation and the patient's audiometric outcome revealed useful information. For the tubotympanic group, there was a greater increase in mean PTA ranging from  $26.3 \text{ dB HL} \pm 7.4$  to  $42.5 \text{ dB HL} \pm 11.6$  as the size of the perforation increased from small to large. This observation is consistent with the well-established biophysics of how the sound transmission through the tympanic membrane is altered by changes in the size of the perforation. An increase in the size of the perforation will generally cause greater alterations in the function of the tympanomeatal assembly by increasing the disruption of the impedance matching between sound and the tympanic membrane [28,29]. Furthermore, although preserving the contiguous ossicular chain is essential for the patient to maintain near normal hearing, it does not compensate for the loss of the acoustic function of the tympanic membrane area that has been substantially altered. Therefore, these findings present a compelling audiological rationale for the provision of an early myringoplasty to patients with medium and large centro-perforations who have experienced adequate success with conservative care [31,32].

A sensorineural component to the hearing loss, defined as having elevated bone conduction thresholds greater than 25 dB HL at any one of the frequencies tested, was observed in 9% of the tubotympanic group and 31% of the atticoantral group (There are a variety of mechanisms that explain the significant cochlear involvement seen in atticoantral disease as compared with other types of aural cholesteatoma, including: Cholesteatomas directly invading the otic capsule, the presence of lytic enzymes (collagenases, acid phosphatases) that cause demineralisation of the bone and may penetrate through the round window, and the destructive action of bacterial endotoxin on cochlear hair cells, cochlear spiral ganglion neurons [15;30]. The mean 4000 Hz bone conduction threshold of 26.4 dB HL in the atticoantral group indicates that there is likely to be early high-frequency sensorineural involvement in this group of

subjects, and this is a significant prognostic factor in determining the likelihood of recovery for hearing, since sensorineural hearing loss is not correctable by middle ear surgery [37].

The mean duration of the disease for our study cohort was  $6.3 \pm 4.8$  years, and reflects the chronic under-management of patients with chronic suppurative otitis media (CSOM) that exemplifies the gaps in ENT services provided in Southern Iraq. Several epidemiological studies have shown that prolonged duration of CSOM is independently associated with more severe audiological outcomes, increases in destruction of the ossicular chain and higher probabilities of complications [3;7]. In Al-Muthanna Governorate, there is no dedicated otology surgical programme at either primary or secondary care levels, therefore the majority of patients with CSOM are treated for years with empirical topical antibiotics and aural toilet until being assessed by specialists. The chronicity of their CSOM is undoubtedly a contributing factor in the high degree of hearing impairment demonstrated in our study cohort, and highlights the need for strengthening of health services across the system.

Being a cross-sectional study, the audiological changes following treatment cannot be assessed in this type of research design. The tertiary care setting at Al-Hussein Teaching Hospital may result in a selection bias towards individuals with more severe forms of CSOM and/or hearing impairment as compared to the general CSOM population that are accessing CSOM services at primary and/or secondary health care levels. Furthermore, microbiological analysis was conducted using standard aerobic culture only and likely resulted in under-identification of the total causative organisms responsible for producing the CSOM; no anaerobic or fungal culture was performed. Descriptive distributions of the antibiotic susceptibility data have been presented without tying into the clinical outcomes, therefore limiting our ability to make conclusions regarding the efficacy of the treatment provided. Despite these limitations, the research represents a comprehensive and systematic characterisation of CSOM in an previously unstudied population; findings from this study are a significant addition to the evidence base both for clinical management and health service planning in Southern Iraq.

## 5. CONCLUSION

Chronic suppurative otitis media is common in wahoo Iraqis more than any other country, is seen most commonly in both sexes between the ages of 12 and 28, has predominantly a tubotympanic classification, has almost equally very high incidence of bilateral disease. The pattern of culture results was also remarkably consistent with what has been reported in other parts of the world, with the most common organisms isolated from these patients being *Staphylococcus aureus* and *Pseudomonas aeruginosa*. Regarding audiologic impairment, most patients have some degree of either conductive hearing loss and the majority of those with atticotympanic disease have severe degrees of conductive hearing loss, with the average degree of impairment among people with atticotympanic disease being much worse than the rest of the population. The presence of larger tympanic membrane perforations and the presence or absence of cholesteatoma are associated with measurable differences in audiologic impairment, such that even among those atticotympanic patients having significant degrees of audiologic impairment, at least some have sensorineural hearing loss. Thus, there is a need for a more aggressive management strategy for this disease which would include earlier referral to ENT specialists, use of culture-directed antibiotics, and sooner surgical correction of larger tympanic membrane perforations to minimise irreversible hearing loss. Additional recommended

strategies to improve the population of Al-Muthanna Governorate who suffer from chronic suppurative otitis media are the establishment of ENTs screening programmes for school-aged children and improvements in surgical capacity/resources at the Al-Hussein Teaching Hospital.

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