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Original Research Article

A Prospective Study of Status of Contralateral Ear in Unilateral Chronic Otitis Media- Based on Otoendoscopy, Audiological, and Radiological Investigations

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ABSTRACT

Background
Chronic otitis media is classically defined as an irreversible inflammation of mucoperiosteal lining of the middle ear cleft, entirely or in parts. The pathological factors that cause otitis media in one ear may also cause it in the other since both ears share the aeration and drainage. The fact that persistent otitis media can develop into chronic otitis media (COM) is another unresolved issue. This study was carried out to evaluate the anatomical and functional alterations of the contralateral ear in patients with unilateral chronic otitis media.

Objectives
The objectives of this study were to identify the anatomical findings of contralateral ear in patients with unilateral chronic otitis media with otoscopy and X-ray mastoids/HRCT Temporal bone and to find out the functional findings of contralateral ear with pure tone audiometry, tympanometry and Eustachian tube function.

Methods
A prospective observational study was conducted over a period of ten months from September 2022 to June 2023 among 90 patients with unilateral ear chronic otitis media attending the ENT OPD of Sri MuthuKumaran Medical College and Research Institute, Chennai. Patients above 18 years of age with chronic otitis media in one ear, irrespective of gender and those who gave informed consent were included in the study. The history and clinical examination were recorded. Otoscopy, pure tone audiometry, tympanometry, X- ray mastoids/HRCT Temporal bone and Eustachian tube function testing were done for all the patients. The data was entered

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in MS Excel and was analyzed using SPSS version 24. Descriptive statistics and inferential statistics such as Chi square test were used. P value < 0.05 was considered significant.

Results

The mean age of the study participants was 39.73 ± 14.64 years. Majority of participants (n=26) were in 31 to 40 years age group. Majority of the participants (n= 57, 63.3%) were females and 33 participants (36.7%) were males. Among the findings of unilateral ear, 69 participants (76.7%) had mucosal type and 21 participants (23.3%) had squamous type of COM. Regarding tympanic membrane findings in contralateral ear, in mucosal type, 21 participants had retracted tympanic membrane and in squamous type, 16 participants had retracted tympanic membrane which was statistically significant. In mucosal type, 63.8% had dysfunction in Eustachian tube and in squamous type 9.5% had dysfunction in Eustachian tube which was statistically significant by Chi square test.

Conclusion

The findings of this study indicate that diverse variations were observed in the contralateral ear of the patients with unilateral chronic otitis media so it should not be thought of as a condition that only affects one ear because it frequently affects both ears. Therefore, in patients with unilateral COM, this study shows the importance of continuous monitoring of the contralateral ear in order to diagnose any changes and, if necessary, give prompt therapeutic intervention. These observations can substantially aid in adding information in understanding the disease evolution in chronic otitis media.

Keywords: Chronic otitis media, hearing loss, Pure tone audiometry, contralateral ear.

INTRODUCTION

The squamous or mucosal type of Chronic Otitis Media, which can be active or inactive, is a common condition. Genetic, environmental, and the anatomical and functional properties of the Eustachian tube are all contributing variables in its multifactorial pathophysiology.[1] COM refers to a long-lasting inflammation of all or a portion of the mucoperiosteal lining of the middle ear cleft. The emergence of COM is influenced by a variety of factors.[2] Considerable factors include genetic predisposition, middle ear infection, mastoid air cell size, tonsils, adenoids, nasal and sinus conditions, low socioeconomic level.[3] A person with COM is likely to have a problem in the contralateral ear, as Eustachian tube dysfunction is the most typical cause of COM.[4] The eustachian tube runs from the middle ear to the nasopharynx regulating the middle ear pressure and draining the middle ear fluid.

The most frequent causes of COM are acute otitis media, low middle ear pressure, and otitis media with effusion (OME).[5] The term "contralateral ear " refers to the asymptomatic ear in patients with unilateral ear complaints of otorrhea, hearing loss and discomfort. It is now widely recognized that COM is rarely a solitary illness.[6] The conditions that cause COM in one ear may also affect the contralateral ear since both ears share an aeration and drainage.[7] Its pathophysiology is still up for debate. A persistent acute infection that results in a subacute state with ongoing otorrhoea that may originate from a mastoid reservoir. By examining clinical features, it may be possible to determine the origin and course of the disease in the poorer ear. The diseased ear might be a precursor to the pathological outcome of the contralateral ear. The biology of advanced ear illness, tubal function, and therapy strategy may all be revealed through the contralateral ear 's study.[8]

The development of COM in a patient appears to be the end outcome of a variety of individual pathological factors. The exact and critical assessment of both ears is essential in determining the patient's prognosis since the ear with confirmed COM can serve as a good guide for the likely evaluation in the contralateral ear.[9] The tympanic membrane (TM) retraction, middle ear effusion, or even perforation, or even the formation of cholesteatoma,

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represent different pathological phases but the same disease, and this transformation concept of the continuum theory could even be detected in the contralateral ear.[10] These sequences represent the progression of COM pathology from mild abnormalities to severe changes.[11,12] Hypoxia and an imbalanced innate immune response were also likely to play a significant role in the pathogenesis of COM.[13]

Hence this study is done to evaluate the anatomical and functional alterations of the contralateral ear in patients with unilateral chronic otitis media.

AIMS AND OBJECTIVES

The aim of this study was to evaluate the anatomical and functional alterations of the contralateral ear in patients with unilateral chronic otitis media. The objectives of this study were to identify the anatomical findings of contralateral ear with otoscopy and X-ray mastoid/ HRCT Temporal bone and to find out the functions of contralateral ear with pure tone audiometry, tympanometry and Eustachian tube function.

MATERIAL AND METHODS

A prospective observational study was conducted over a period of ten months from September 2022 to June 2023 among patients with unilateral ear chronic otitis media attending the ENT OPD of Sri MuthuKumaran Medical College Hospital and Research Institute, Chennai. The minimum sample size was calculated to 90. Ethical clearance was obtained from the Institutional Ethical Committee, Sri Muthukumaran Medical College Hospital and Research Institute.

Patients above 18 years of age with chronic otitis media irrespective of gender and those who gave informed consent were included in the study. Those with history of previous ear surgery, congenital ear disease and temporal bone disease or trauma were excluded. Chronic otitis media was defined as a chronic inflammation of middle ear cleft, the inflammation producing discharge which occurs through a tympanic membrane perforation or cholesteatoma for more than 6 weeks. The history and clinical examination were recorded. Otoscopy, pure tone audiometry, tympanometry, X- ray mastoids/HRCT Temporal bone and Eustachian tube function testing were done for all the patients. All observations through these different modalities of the contralateral ear were recorded. The ear diagnosed with chronic otitis media were grouped as mucosal type and squamous type.

Statistical Analysis

The data was entered in MS Excel and was analyzed using SPSS version 24. P value < 0.05 was considered significant. Data were expressed in graphs, tables and charts wherever necessary.

RESULTS

The mean age of the study participants was 39.73 ± 14.64 years. Majority of participants (n=26) were in 31 to 40 years age group followed by 20 participants in 21 to 30 years age group. 16 participants were from 51 to 60 years of age and 15 participants were from 41 to 50 years of age. 7 participants were less than 20 years, 4 participants were from 61 to 70 years of age and 2 participants were from 71 to 80 years of age. Majority of the participants (n= 57, 63.3%) were females and 33 participants (36.7%) were males.

Among the findings of unilateral ear, 69 participants (76.7%) had mucosal type and 21 participants (23.3%) had squamous type of COM. Regarding the tympanic membrane findings

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of contralateral ear, 37 participants (41.1%) had retracted tympanic membrane, 16 participants (17.8%) had thin tympanic membrane, 16 participants (17.8%) had tympanosclerotic patch and 21 participants (23.3%) had normal tympanic membrane. (Table 1)

35 participants (38.9%) had pneumatized mastoid, 30 participants (33.3%) had sclerotic mastoid and 25 participants (27.8%) had diploic mastoid. 28 participants (31.1%) had conductive hearing loss, 16 participants (17.8%) had mixed hearing loss, 1 participant (1.1%) had sensorineural hearing loss and 45 participants (50%) had normal hearing. (Table 1)

Regarding the tympanometry findings, 29 participants (32.2%) had type A, 45 participants (50%) had type B and 16 participants (17.8%) had type C. 46 participants (51.1%) had dysfunctional eustachian tube and 44 participants (48.9%) had patent eustachian tube. (Table 1).

Contralateral ear findings		**Frequency (n=90)**	**Percentage**
Tympanic membrane	Normal	21	23.3
	Retracted	37	41.1
	Thin	16	17.8
	Tympanosclerotic patch	16	17.8
Pneumatization	Pneumatized mastoid	35	38.9
	Sclerotic mastoid	30	33.3
	Diploic mastoid	25	27.8
PTA	Normal	45	50
	Conductive hearing loss	28	31.1
	Mixed	16	17.8
	Sensorineural	1	1.1
Tympanometry	A	29	32.2
	B	45	50
	C	16	17.8
Eustachian tube	Dysfunction	46	51.1
	Patent	44	48.9

Table 1. Contralateral ear findings in the study participants

Regarding contralateral tympanic membrane findings, in mucosal type, 24.6% had normal tympanic membrane, 30.4% had retracted tympanic membrane, 23.2% had thin tympanic membrane and 21.7% had tympanosclerotic patch. In squamous type, 19% had normal tympanic membrane, 76.2% had retracted tympanic membrane and 4.8% had tympanosclerotic patch. This difference was statistically significant by Chi square test. (Table 2)

Type of COM	**Tympanic membrane findings**					**Chi square value**	**P value**
	Normal	**Retracted**	**Thin**	**Tympano sclerotic patch**	**Total**		
Mucosal	17 24.6%	21 30.4%	16 23.2%	15 21.7%	69 100%	15.89	**0.001***
Squamous	4 19%	16 76.2%	0	1 4.8%	21 100%		
Total	21 23.3%	37 41.1%	16 17.8%	16 17.8%	90 100%		

Table 2. Association between type of COM and tympanic membrane finding

*- statistically significant by Chi square test

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Regarding pneumatization in contralateral ear, in mucosal type, 39.1% had pneumatized mastoid, 34.8% had sclerotic mastoid and 26.1% had diploic mastoid. In squamous type, 38.1% had pneumatized mastoid, 28.6% had sclerotic mastoid and 33.3% had diploic mastoid. This difference was not statistically significant by Chi square test. (Table 3)

Type of COM	Pneumatization				Chi square value	P value
	Pneumatized mastoid	Sclerotic mastoid	Diploic mastoid	Total		
Mucosal	27 39.1%	24 34.8%	18 26.1%	69 100%	0.49	0.78
Squamous	8 38.1%	6 28.6%	7 33.3%	21 100%		
Total	35 38.9%	30 33.3%	25 27.8%	90 100%		

Table 3. Association between type of COM and pneumatization in contralateral ear

In contralateral ear pure tone audiometry in the study participants, in mucosal type, 47.8% had normal hearing, 29% had conductive hearing loss, 21.7% had mixed hearing loss and 1.4% had sensorineural hearing loss. In squamous type, 57.1% had normal hearing, 38.1% had conductive hearing loss and 4.8% had mixed hearing loss. This difference was not statistically significant by Chi square test. (Table 4)

Type of COM	Pure Tone Audiometry					Chi square value	P value
	Normal	Conductive hearing loss	Mixed hearing loss	Sensorineural hearing loss	Total		
Mucosal	33 47.8%	20 29%	15 21.7%	1 1.4%	69 100%	3.62	0.30
Squamous	12 57.1%	8 38.1%	1 4.8%	0	21 100%		
Total	45 50%	28 31.1%	16 17.8%	1 1.1%	90 100%		

Table 4. Association between type of COM and PTA in contralateral ear

Regarding tympanometry findings, in mucosal type, 29% had type A, 50.7% had type B and 20.3% had type C. In squamous type, 42.9% had type A, 47.6% had type B and 9.5% had type C. This difference was not statistically significant by Chi square test. (Table 5)

Type of COM	Tympanometry findings				Chi square value	P value
	A	B	C	Total		
Mucosal	20 29%	35 50.7%	14 20.3%	69 100%	2.04	0.36
Squamous	9 42.9%	10 47.6%	2 9.5%	21 100%		
Total	29 32.2%	45 50%	16 17.8%	90 100%		

Table 5. Association between type of COM and Tympanometry findings

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Regarding Eustachian tube patency in contralateral ear, in mucosal type, 36.2% had patent eustachian tube and 63.8% had dysfunction in Eustachian tube. In squamous type, 90.5% had patent eustachian tube and 9.5% had dysfunction in Eustachian tube. This difference was statistically significant by Chi square test. (Table 6)

Type of COM	Eustachian tube findings			Chi square value	P value
	Patent	Dysfunction	Total		
Mucosal	25 36.2%	44 63.8%	69 100%	18.95	< 0.001*
Squamous	19 90.5%	2 9.5%	21 100%		
Total	44 48.9%	46 51.1%	90 100%		

Table 6. Association between type of COM and Eustachian tube findings

*- statistically significant by Chi square test

DISCUSSION

In our study, the mean age of the study participants was 39.73 ± 14.64 years. Majority of participants (n=26) were in 31 to 40 years age group. Similar to our results, the study done by Hooda et al[14] reported that, mean age of participants was 33.06 years. Khan et al[15] reported that majority were from 21 to 30 years followed by 31 to 40 years. Jain et al[16] stated that most of the patients (42.32%) were in the age group of 16–30 years.

Majority of the participants (n= 57, 63.3%) were females and 33 participants (36.7%) were males. This was similar to the results by Raghavan et al[1] who reported female predominance of (65.5%) compared with males (34.5%). Hooda et al[14] reported that 51% were females. Contrasting results were reported by Jain et al[16] who reported that 51.92% were males. Khan et al[15] reported that 59% were females and 41% were males.

Majority of our study participants were from lower socioeconomic status. Bhadra et al[17] reported that, malnutrition, which frequently goes hand in hand with low socioeconomic status, lowers the immune system and puts poor children at higher risk of illness. Lack of personal cleanliness likely allows bacteria to grow on the body and in the environment, which can lead to infection. In their study, 61% of the patients exhibited poor personal hygiene. It interferes with students' academic achievement. They were staying away from sports activities, particularly water sports. A lot of young adults are denied employment because they have chronic otitis media of the active squamous type. These patients' low socioeconomic status causes them to fall even further behind financially as a result of increased financial strain.

Among the findings of unilateral ear, 69 participants (76.7%) had mucosal type and 21 participants (23.3%) had squamous type of COM. This was similar to the results by Raghavan et al[1] who reported 69% had mucosal type and 31% had squamous type of involvement. Khan et al[15] reported that 90% had tubotympanic disease and 10% had atticoantral disease.

In the tympanic membrane findings of contralateral ear in our study were in 37 participants (41.1%) had retracted tympanic membrane, 16 participants (17.8%) had thin tympanic membrane, 16 participants (17.8%) had tympanosclerotic patch and 21 participants (23.3%) had normal tympanic membrane. In mucosal type, 24.6% had normal tympanic membrane, 30.4% had retracted tympanic membrane, 23.2% had thin tympanic membrane and 21.7% had tympanosclerotic patch. In squamous type, 19% had normal tympanic membrane, 76.2% had retracted tympanic membrane and 4.8% had tympanosclerotic patch. This difference

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was statistically significant by Chi square test. This was in contrast to the study by Raghavan et al[1] who reported in mucosal type, 25% had retracted tympanic membrane, 27% had tympanosclerotic patches and 15% had effusion in tympanic membrane. In squamous type, 14% had retracted TM, 11% had tympanosclerotic patches and 7% had effusion. This difference however was not statistically significant. Jain et al[16] reported that, among 65 ears with squamous type of COM were studied, out of which, 26 ears (23 patients) had Pars Flaccida and 39 ears (29 patients) had Pars Tensa Squamous Otitis Media. Khan et al[15] reported that 68% had abnormal tympanic membrane. Thampi et al[18] stated that in mucosal type, 41.17% patients had abnormal TM. Pars Tensa (PT) retraction the majority finding. In squamosal disease, the retraction of PT was most common (36.36%). This difference was not statistically significant.

Regarding pneumatization, in mucosal type, 39.1% had pneumatized mastoid, 34.8% had sclerotic mastoid and 26.1% had diploic mastoid. In squamous type, 38.1% had pneumatized mastoid, 28.6% had sclerotic mastoid and 33.3% had diploic mastoid. This difference was not statistically significant by Chi square test.

In our study, 35 participants (39.1%) had pneumatized mastoid, 24 participants (34.8%) had sclerotic mastoid and 18 participants (26.1%) had diploic mastoid in the contralateral ear. In mucosal type, 39.1% had pneumatized mastoid, 34.8% had sclerotic mastoid and 26.1% had diploic mastoid. In squamous type, 38.1% had pneumatized mastoid, 28.6% had sclerotic mastoid and 33.3% had diploic mastoid. This difference was not statistically significant by Chi square test. Jain et al[16] reported that in cases of Pars Flaccida squamous otitis media 46.15% had primary sclerotic/diploic and contracted mastoid pneumatization pattern and 53.85% were found to have secondary sclerosis in well pneumatized mastoid. In cases of Pars Tensa squamous otitis media 38.46% had primary sclerotic/diploic and contracted mastoid pneumatization pattern and 61.54% had secondary sclerosis in pneumatized mastoid. This difference was statistically significant. Raghavan et al[1] in contrast reported no significant association between mastoidization and the type of COM. Thampi et al[18] reported that contralateral ear was pneumatized in 59% of total cases. 54.5% of contralateral ear were pneumatised in squamosal cases as compared to 67.6% in mucosal cases. Hooda et al[14] in reported that 17.1% patients in mastoid type and 20% patients in squamous type revealed mastoid sclerosis and decreased pneumatisation in contralateral ears. Ossicular chain was intact in all 100% patients of both the groups. Khan et al[15] reported that 90% had pneumatized mastoid, 60% had sclerosed mastoid and 50% had diploic mastoid.

Among the study participants, 28 participants (31.1%) had conductive hearing loss, 16 participants (17.8%) had mixed hearing loss, 1 participant (1.1%) had sensorineural hearing loss and 45 participants (50%) had normal hearing. In mucosal type, 47.8% had normal hearing, 29% had conductive hearing loss, 21.7% had mixed hearing loss and 1.4% had sensorineural hearing loss. In squamous type, 57.1% had normal hearing, 38.1% had conductive hearing loss and 4.8% had mixed hearing loss. This difference was not statistically significant by Chi square test. Raghavan et al[1] reported in mucosal type, 34.7% had conductive hearing loss, 12.9% had sensorineural hearing loss and 16.1% had mixed hearing loss. In squamous type, 17.7% had conductive hearing loss, 9.7% had sensorineural hearing loss and 8.9% had mixed hearing loss. This difference however was not statistically significant. Thampi et al[18] stated that 70% of the contralateral ear had no hearing impairment. Squamosal cases had mild increased incidence of hearing impairment. Hooda et al[14] reported that by pure tune audiometry in mucosal type contralateral ear hearing was normal in 74.3%, 22.9% patients were having mild level of hearing loss, 2.86% patient were having moderate level of hearing loss. In squamous type, 77.1% had normal hearing and 22.9% patients were having mild hearing loss.

In the study regarding the tympanometry findings, 29 participants (32.2%) had type A, 45 participants (50%) had type B and 16 participants (17.8%) had type C. In mucosal type, 29% had type A, 50.7% had type B and 20.3% had type C. In squamous type, 42.9% had type

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A, 47.6% had type B and 9.5% had type C. This difference was not statistically significant by Chi square test. Raghavan et al[1] reported that in mucosal type, 19.5% had type A, 37.5% had type B and 12% had type C. In squamous type, 9.5% had type A, 17% had type B and 4.5% had type C. This difference however was not statistically significant in their study. Thampi et al[18] reported that 80% had normal tympanometry findings. Mucosal disease was reported to have higher incidence of type B and C curve. Tympanometry findings of contralateral ear were also significantly correlating.

In our study, 46 participants (51.1%) had dysfunctional eustachian tube and 44 participants (48.9%) had patent eustachian tube. In mucosal type, 36.2% had patent eustachian tube and 63.8% had dysfunction in Eustachian tube. In squamous type, 90.5% had patent eustachian tube and 9.5% had dysfunction in Eustachian tube. This difference was statistically significant by Chi square test were in Jain et al[16] reported that, in cases of Pars flaccida squamous otitis media, 38.5% had normal Eustachian function and 61.5% were diagnosed to have Eustachian dysfunction. In patients with Pars tensa squamous otitis media, 38.5% had normal Eustachian function 61.5% were diagnosed to have Eustachian dysfunction. He concluded that Eustachian tube dysfunction, had statistically significant association with both pars flaccida and pars tensa disease ($P < 0.01$).

This study shows that mastoid pneumatization pattern and Eustachian tube dysfunction could be separate etiological variables for squamous otitis media leading to negative middle ear pressure and cause squamous type COM. Poorly pneumatized mastoids have a tendency to establish a negative gas balance with persistently high negative pressure and subsequent chronic sequelae because they lack the buffering action on middle ear pressure. In ears with primary sclerosis or a diploid type of pneumatization pattern, pars flaccida squamous disease was marginally more prevalent than pars tensa disease. In ears with inadequately pneumatized mastoids (primary sclerotic or diploic) and typical Eustachian function, pockets of pars tensa can also develop posteriorly.

In our study around 70-80% had findings in contralateral ear. There was an incidence of structural abnormalities of the contralateral ear in cases of unilateral COM of both squamous, and mucosal types as being mainly in the form of TM retraction in the squamous type and of thinning TM in the mucosal type. Eustachian tube dysfunction was more in mucosal group than in squamous group which was also statistically significant.

CONCLUSION

Diverse problems in the ear on the opposite side may exist in more than 50% of COM patients. The findings of this study suggest that COM should not be thought of as a condition that only affects one ear because it frequently affects both ears. Therefore, in patients with unilateral COM, this study shows the importance of continuous monitoring of the contralateral ear in order to diagnose any changes and, if necessary, give prompt therapeutic intervention. These observations can substantially aid in adding information in understanding the disease evolution in chronic otitis media. There is little published research on the subject, with more data and experience, can learn how and when to use the knowledge.

Recommendations

Conducting this study in a large scale in many tertiary care centers is recommended in the future.

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