

## Pattern And Degree Of Hearing Loss In Chronic Suppurative Otitis Media

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**Abstract:** Hearing loss is a major public health problem in developing countries. About 60% chronic suppurative otitis media (CSOM) patients have hearing loss with pattern and degree vary greatly. Conductive hearing loss is the most common pattern of hearing loss in CSOM but the infection and inflammation components transmit to the middle ear through round window can cause sensorineural hearing loss. The degree of hearing loss is determined by the size and site of tympanic membrane perforation, ossicles damage, and the presence of granulation tissue or cholesteatoma. This study assessed the pattern and degree of hearing loss in CSOM based on determinants previously mentioned. This observational descriptive study was carried out in 186 CSOM patients who came to ENT-Neurotology Outpatient Department of Dr. Saiful Anwar Hospital Malang within a period of 3 years. The majority pattern of hearing loss was conductive hearing loss (59%), followed by mixed hearing loss (27%) and sensorineural hearing loss (8%). 5% of cases had normal hearing. Most of the CSOM tubotympanic type cases had moderate (34,75%) and mild conductive hearing loss (19,68%), whereas most of the CSOM atticointral type cases had moderately-severe conductive hearing loss (22,03%). Sensorineural hearing loss was mostly found in perforation cases with cholesteatoma and destruction of ossicles (47,6%). Based on perforation size (central, subtotal, total), there was not an increase in the degree of hearing loss with increasing of perforation size. This is probably due to limited data about the site of perforation according to quadrant (anterior/posterior/inferior) and the specified size of perforation (small, moderate, large).

**Keywords:** Cholesteatoma, CSOM, hearing loss, tubotympanic type, tympanic membrane perforation

### I. Introduction

Hearing loss is a major public health problem in developing countries. About 2/3 population with hearing loss come from developing countries.<sup>1</sup> Hearing loss causes communication problems, thus affects social and personal living.<sup>2,3</sup>

About 60% CSOM patients have hearing loss.<sup>4</sup> CSOM is a chronic infection in the middle ear with tympanic membrane perforation and persistent or recurrent drainage from middle ear more than 2 months.<sup>5</sup>

Conductive hearing loss is the most common pattern hearing loss in CSOM with varying degree between 20 to 60 dB. Conductive hearing loss can be caused by tympanic membrane perforation, middle ear atelectasis, tympanosclerosis, ossicles destruction, and cholesteatoma. Infection and inflammation components transmit to the middle ear through round window cause cochlear destruction and sensorineural hearing loss.<sup>6</sup>

A study by Kumar, *et al.*,<sup>7</sup> in 50 patients aged 15-60 years with CSOM tubotympanic type showed that 92.18% of patients had conductive hearing loss and 7.82% of patients had sensorineural hearing loss. Most of the hearing loss were in range of 26-40 dB in 50% of patients and between 41 and 55 dB in 42.19% of patients.

The degree of hearing loss is determined by the size and site of the tympanic membrane perforation, ossicles damage, and the presence of granulation tissue or cholesteatoma.<sup>6</sup>

The larger the perforation, the less the surface of the membrane as collectors of sound energy. The sound eventually only be accommodated in the rest of the posterior quadrant of the tympanic membrane where the ossicle is or in the place where ossicle is located. The smaller the rest of the tympanic membrane, the smaller the ossicular coupling thus remain only the acoustic coupling. This will cause a maximum ABG of 42 dB.<sup>8</sup> Large perforation in the tympanic membrane generally causes hearing loss by 40-50 dB while total perforation causes hearing loss up to 60 dB.<sup>9</sup> Differences in the degree of hearing loss in the same perforation size due to differences in the volume of the middle ear and mastoid cavity of each ear.<sup>8</sup>

The site of the perforation also affects the degree of hearing loss. Perforation of the posterior part of the tympanic membrane will cause greater hearing loss than the perforation of the anterior part.<sup>7,9,10</sup> Perforation of the posterior part of the tympanic membrane that expose the round window membrane will result in more severe conductive hearing loss because the tympanic membrane no longer shields the round window from sound (baffle effect).<sup>6</sup> Perforation at or near the attachment of the tympanic membrane to the handle of malleus (malleolar) will also result in a greater hearing loss than same sized perforation at a different site.<sup>7,10,11</sup> This is because if

the contact between the tympanic membrane and malleus manubrium is lost, the ability of handle of malleus to move will be affected. The tympanic membrane is effective only so far as it communicates its motion through its attachment to the handle of malleus and not otherwise.<sup>7</sup>

Granulation tissue is the most common finding associated with CSOM and is a consequence of inflammation. Granulation tissue within the middle ear cavity will inhibit ossicular mobility, causing conductive hearing loss. Granulation tissue that has eroded much of the ossicular chain may only cause minimal hearing loss if sound is able to be transmitted through these lesions to reach inner ear via stapes or footplate.<sup>6</sup>

Cholesteatoma in the middle ear cavity can affect hearing. The degree of hearing loss depends on the size and whether cholesteatoma is associated with the ossicular chain or whether its expansion has eroded the ossicular chain.<sup>9</sup>

The association of incus and stapes through soft tissues will improve hearing at low frequencies. The elastic association between ossicles will transmit low frequency sounds, but will not effectively transmit high frequency sounds.<sup>13</sup> The growth of cholesteatoma will establish the association between the tympanic membrane and stapes, causing hearing improvement that is "paradox" with the development of the disease.<sup>7, 13</sup> When left untreated, the further growth of cholesteatoma will cause sensorineural hearing loss due to erosion into cochlea.<sup>13</sup>

Cochlear damage in patients with CSOM might due to bacterial toxins that diffuse through the round window membrane. These toxins may cause biochemical changes in the perilymph and endolymph, causing damage of the Organ of Corti. Macromolecules flow such as proteins in perilymph more often occurs in the state of the middle ear inflammation, due to increased vascular permeability.<sup>12</sup> Damage to the hair cells of the cochlea especially those at the cochlear base, where the hair cells are sensitive to high frequency sound.<sup>13</sup>

A Study by Kasliwal, *et al.*,<sup>12</sup> in 510 CSOM cases with sensorineural hearing loss showed that the tympanic membrane perforation was mostly attic perforation (40.2%), followed by central-small (10.6%), central-moderate (20.8%), central-large (20.4%) and subtotal perforation (8%). Cholesteatoma found in 51.6% of cases. The ossicular chain was found intact in 51.2% of cases. There was a significant association between the sensorineural hearing loss and the presence of cholesteatoma and the destruction of ossicles.

Sensorineural hearing loss in CSOM might also be caused by mechanical occlusion of the oval window by granulation tissue, cholesteatoma or pus; fixation of the ossicular chain due to chronic inflammatory process (Carhart's effect) in otosclerosis; or fistula induced by the presence of cholesteatoma (caused sensorineural hearing loss, vertigo and nystagmus).<sup>13</sup>

The objective of this present study is to assess the pattern and degree of hearing loss in CSOM based on the type of CSOM, size and site of perforation, and the presence of pathological tissues (granulation, cholesteatoma, and destruction of ossicles).

## **II. Method**

This observational descriptive study was carried out in ENT-Neurotology Outpatient Department of Dr. Saiful Anwar Hospital Malang during March - April 2013. All CSOM patients who came to ENT-Neurotology Outpatient Department of Dr. Saiful Anwar Hospital Malang in the period January 1, 2008 - December 31, 2012 were included in this study. Data was collected from the medical records of patients who met the CSOM diagnosis and underwent pure tone audiometry. CSOM is defined by a chronic infection in the middle ear with tympanic membrane perforation and persistent or recurrent drainage from middle ear more than 2 months.

The samples were assessed based on gender, age, duration of otorrhea, laterality of CSOM (unilateral, bilateral), type of CSOM (tubotympanic, atticointral), site of perforation (central, subtotal, total, marginal, attic), and presence of pathological tissues (granulation, cholesteatoma, destruction of ossicles).

Based on the type of hearing loss, the samples are grouped into:<sup>14, 15</sup>

1. Normal hearing: air conduction (AC) and bone conduction (BC) are in the normal range ( $\leq 25$  dB), AC and BC overlap (no gap).
2. Conductive hearing loss: BC normal or  $< 25$  dB, AC  $> 25$  dB, there is a gap (there is a difference between AC and BC greater than or equal to 10 dB in minimum 2 adjacent frequencies).
3. Sensorineural hearing loss: AC and BC  $> 25$  dB, AC and BC overlap (no gap).
4. Mixed hearing loss: BC  $> 25$  dB, AC is greater than BC, there is a gap.

Based on the degree of hearing loss, the samples are grouped into: Normal (hearing range 0-25 dB), Mild ( $> 25$ -40 dB), moderate ( $> 40$ -55 dB), moderately severe ( $> 55$ -70 dB), severe ( $> 70$ -90 dB), and profound ( $> 90$  dB).<sup>15</sup>

## **III. Results**

There were 208 CSOM patients who came to ENT-Neurotology Outpatient Department of Saiful Anwar Hospital Malang in the period January 1, 2008 - December 31, 2012. 14 patients aged over 60 years who had a risk of presbycusis (bilateral sensorineural deafness),<sup>16,7</sup> patients who had a history of mastoidectomy or

myringoplasty, and 1 patient who had external ear abnormalities (external auditory canal stenosis) which might interfere with the actual results of hearing loss caused by CSOM were excluded. Therefore, further data analysis was performed on 186 patients.

Out of 186 patients, 54,84% of patients were female and 45,16% of patients were male. The majority of patients were among the age group 21-30 years (24,73%) (Table 1).

**Table 1.** Distribution of patients based on gender and age

Age (years)	Male		Female		Total	
	No. of patients	%	No. of patients	%	No. of patients	%
7-10	3	1.61	4	2.15	7	3.76
11-20	17	9.14	19	10.22	36	19.35
21-30	28	15.05	18	9.68	46	<b>24.73</b>
31-40	14	7.53	18	9.68	32	17.20
41-50	13	6.99	25	13.44	38	20.43
51-60	9	4.84	18	9.68	27	14.52
Total	84	<b>45.16</b>	102	<b>54.84</b>	186	100

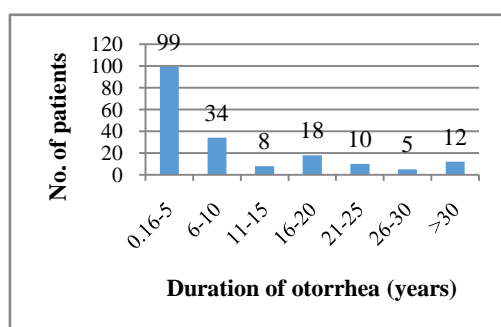


Figure 1. Distribution of patients based on duration of otorrhea

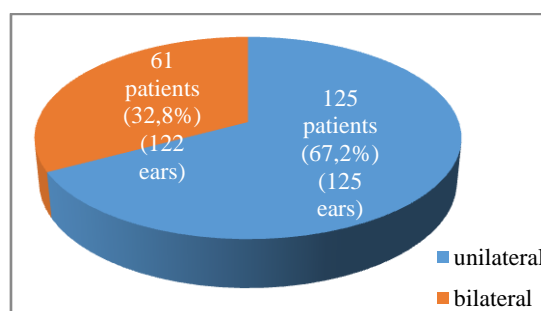


Figure 2. Distribution of patients based on CSOM laterality

Most patients came after had otorrhea for 2 months until 5 years (53,23%) (Fig.1). CSOM was more common in one ear/unilateral (67,2%) than both ears/bilateral (32,8%) (Fig.2).

CSOM tubotympanic type was found in 188 ears (76,11%) and CSOM atticoantral type (with cholesteatoma) was found in 59 ears (23,89%). Most type of perforation in CSOM cases was central perforation (40,08%). In CSOM tubotympanic type, most cases had central (51,6%) and subtotal (25%) perforation. In CSOM atticoantral type, most cases had total (47,46%) and attic (42,73%) perforation (Table 2).

**Table 2.** Distribution of patients based on CSOM type and site of perforation

Site of perforation	Tubotympanic type		Atticoantral type		Total	
	No. of ears	%	No. of ears	%	No. of ears	%
Central	97	<b>51.60</b>	2	3.39	99	<b>40.08</b>
Subtotal	47	<b>25.00</b>	4	6.78	51	20.65
Total	31	16.49	28	<b>47.46</b>	59	23.89
Marginal	6	3.19	0	0.00	6	2.43
Attic	7	3.72	25	<b>42.37</b>	32	12.96
Total	188	100	59	100	247	100

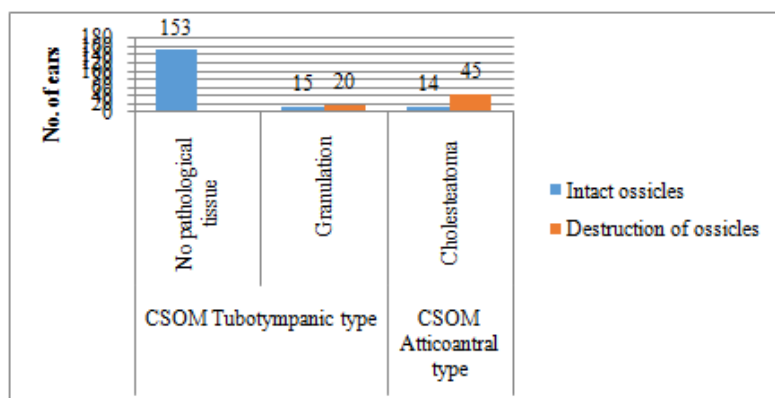


Figure 3. Distribution of patients based on integrity of ossicles and pathological tissue.

Most ears with CSOM had intact ossicles (182 ears (73,68%)). Out of 188 ears with CSOM tubotympanic type, most of them had intact ossicles (168 ears (89,36%)). Out of 59 ears with CSOM atticoantral type, most of them had a destruction of ossicles (76,27%). Based on pathological tissue, most ears with CSOM had no pathological tissue (153 ears (61,94%)). Granulation tissues were found in 35 ears (14,17%) (Fig. 3).

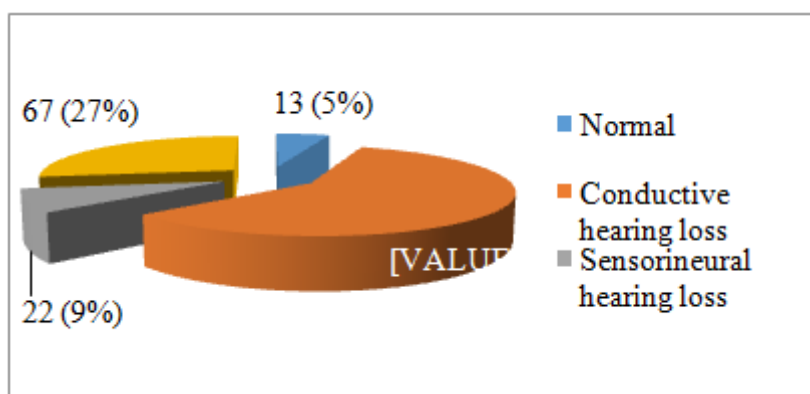


Figure 4. Distribution of hearing pattern in CSOM

Most cases had conductive hearing loss (59%), followed by mixed hearing loss (27%) and sensorineural hearing loss (8%). 5% of cases had normal hearing threshold (Fig. 4).

Out of 188 ears with CSOM tubotympanic type, 115 ears (61,17%) had conductive hearing loss, 54 ears (28,72%) had mixed hearing loss, 11 ears (5,85%) had sensorineural hearing loss, and 8 ears (4,26%) had normal hearing threshold. Most of the CSOM tubotympanic type cases had moderate conductive hearing loss (65 ears (34,75%)), followed by mild conductive hearing loss (37 ears (19,68%)) (Table 3).

Out of 59 ears with CSOM atticoantral type, 30 ears (50,85%) had conductive hearing loss, 14 ears (23,73%) had mixed hearing loss, 10 ears (16,95%) had sensorineural hearing loss, and 5 ears (8,48%) had normal hearing threshold. Most of the CSOM atticoantral type cases had moderately-severe conductive hearing loss (13 ears (22,03%)) (Table 3).

Table 3. Distribution of type and degree of hearing loss in CSOM

Degree	Hearing pattern							
	Normal		Conductive hearing loss		Sensorineural hearing loss		Mixed hearing loss	
	TT	AA	TT	AA	TT	AA	TT	AA
Mild	8	5	37	5	3	0	1	0
Moderate			65	9	0	2	3	1
Moderately-Severe			11	13	2	0	16	3
Severe			2	1	2	0	20	6
Profound			0	2	4	8	14	4
Total	8	5	115	30	11	10	54	14
%	4.26	8.48	61.17	50.85	5.85	16.95	28.72	23.73

TT : CSOM tubotympanic type, AA: CSOM atticoantral type

Out of 13 ears with normal hearing threshold, 2 ears had central perforation (without pathological tissue), 4 ears had total perforation (1 without pathological tissue, 2 with granulation tissues, 1 with cholesteatoma), 2 ears had marginal perforation (without pathological tissue), and 5 ears had attic perforation (4 with granulation, 1 with cholesteatoma) (Table 4).

Table 4. Distribution of normal hearing threshold based on perforation site and pathological tissue

Site of perforation	Pathological tissue	No. of ears	%
Central	(-)	2	15.4
Total	(-)	1	7.7
	Granulation + intact ossicles	1	7.7
	Granulation + destruction of ossicles	1	7.7
	Cholesteatoma + destruction of ossicles	1	7.7
Marginal	(-)	2	15.4
Attic	Granulation + intact ossicles	1	7.7
	Granulation + destruction of ossicles	3	23.1
	Cholesteatoma + destruction of ossicles	1	7.7
Total		13	100.0

The effect of perforation size on the degree of hearing loss was assessed at CSOM cases with central, subtotal or total perforation which had conductive hearing loss. Based on perforation size (central, subtotal, total), there was no increase in the degree of hearing loss with increasing of perforation size. Mild conductive hearing loss was found in 22 ears with central perforation, 11 cases with subtotal perforation, and 5 cases with total perforation. Moderate conductive hearing loss was found in 29 cases with central perforation, 20 cases with subtotal perforation, and 15 cases with total perforation. Moderately-severe conductive hearing loss was found in 6 cases with central perforation, 6 cases with subtotal perforation, and 7 cases with total perforation. Severe conductive hearing loss was found in 1 case with central perforation and 1 case with subtotal perforation. Profound conductive hearing loss was found in 1 case with central perforation and 1 case with total perforation (Table 5).

Table 5. Distribution of conductive hearing loss based on perforation site and pathological tissue

Site of perforation	Pathological tissue	Degree of hearing loss					Total no. of ears
		Mild	Moderate	Moderately-Severe	Severe	Profound	
Central	No pathological tissue	22	28	6	1	0	57
	Cholesteatoma + destruction of ossicles	0	1	0	0	1	2
Subtotal	No pathological tissue	7	15	2	1	0	25
	Granulation + intact ossicles	1	3	2	0	0	6
	Granulation + destruction of ossicles	2	2	0	0	0	4
	Cholesteatoma + destruction of ossicles	1	0	2	0	0	3
Total	No pathological tissue	2	7	1	0	0	10
	Granulation + intact ossicles	1	3	0	0	0	4
	Granulation + destruction of ossicles	0	3	0	0	0	3
	Cholesteatoma + destruction of ossicles	2	2	6	0	1	11

Sensorineural hearing loss was found in 21 ears. Most ears had tympanic membrane perforation with cholesteatoma and destruction of ossicles (33,3% in total perforation, 14,3% in attic perforation). In the remaining, sensorineural hearing loss also was found in tympanic membrane perforation without pathological tissue (19% in central perforation, 9,52% in total perforation, and 4,76% in marginal perforation) and in tympanic membrane perforation with granulation tissues (4,76% in central perforation and 14,28% in total perforation) (Table 6).

Table 6. Distribution of sensorineural hearing loss based on perforation site and pathological tissue

Site of perforation	Pathological tissue	Degree of hearing loss					Total of ears	
		Mild	Moderate	Moderately-Severe	Severe	Profound	No.	%
Central	No pathological tissue	1	0	2	0	1	4	19.0
	Granulation + destruction of ossicles	0	0	0	1	0	1	4.8

Total	No pathological tissue	1	0	0	0	1	2	9.5
	Granulation + intact ossicles	0	0	0	0	1	1	4.8
	Granulation + destruction of ossicles	0	0	0	1	1	2	9.5
	Cholesteatoma + destruction of ossicles	0	1	0	0	6	7	33.3
Marginal	No pathological tissue	1	0	0	0	0	1	4.8
	Cholesteatoma + destruction of ossicles	0	1	0	0	2	3	14.3
Total		3	2	2	2	12	21	100.0

#### IV. Discussion

There were 208 CSOM patients who came to ENT-Neurotology Outpatient Department of Saiful Anwar Hospital Malang in the period January 1, 2008 - December 31, 2012. 22 patients who had factors which might interfere with the actual results of hearing loss caused by CSOM were excluded. Therefore, further data analysis was performed on 186 patients.

Both sexes were almost equally affected. 55% of patients is female and 45% of patients is male. This is in agreement with another reports.<sup>17</sup>

The majority of patients were among the age group 21-30 years (24,73%) (Table 1). This is very well in agreement with a study by Islam,*et al.*,<sup>1</sup> which reported that the maximum number of patients were in the age group 21-30 years (38,67%). The number of patients commonly decreases as age increases, but that is not shown in this study.

Most patients came after had otorrhea for 2 months until 5 years (53,23%). This is similar to that reported by Akinpelu, *et al.*<sup>18</sup> Their study reported that most patients came after had otorrhea for 2 months – 5 years. This indicates the increasing public awareness of health issues and hearing disorders that affect their professional or social life so that the patient or the patient's parents immediately seek treatment.

CSOM was more common in one ear/unilateral (67,2%) than both ears/bilateral (32,8%). This is similar to that reported by Akinpelu, *et al.*,<sup>18</sup> which showed that 67,5% of patients had unilateral CSOM and 32,5% of patients had bilateral CSOM.

CSOM tubotympanic type was found in 188 ears (76,11%) and CSOM atticoantral type (with cholesteatoma) was found in 59 ears (23,89%). The number of cholesteatoma cases found in this study was higher than those in the literature which reported that cholesteatoma was found in 10% of CSOM cases.<sup>6</sup>This is because almost half of this study samples (44.62%) were the patients undergoing mastoidectomy surgery. Audiometry examination has not been carried out routinely in all patients with CSOM.

Most of the type of perforation found in this study was central perforation (40,08%). This is approximate to that reported by Akinpelu, *et al.*,<sup>18</sup> which showed that most of the CSOM cases (95,6%) had central perforation.

In CSOM tubotympanic type, most cases had central (51,6%) and subtotal (25%) perforation. This is similar to that reported in the literature.<sup>17</sup> In this study, cholesteatoma was more common in attic (42,73%) and total perforation (47,46%). This is consistent with the literature which reported that cholesteatoma commonly found in attic and marginal perforation. Aquino,*et al.*<sup>19</sup> reported that 59,8% of cholesteatoma cases were found in attic perforation, 13,7% marginal perforation, 13,2% total perforation, and 3,2% central perforation.

In this study, granulation tissues were found in 35 ears (14,17%). Similar finding were reported by Akinpelu,*et al.*<sup>18</sup> Their study reported that granulation tissues were found in 10% of cases.

Most cases had intact ossicles (73,68%). In the CSOM tubotympanic type, most cases had intact ossicles (89,36%), while in the CSOM atticoantral type, most cases had destruction of ossicles (76,27%). This is consistent with a study by Varshpney,*et al.*,<sup>20</sup> which reported that in most cases with CSOM tubotympanic type had intact ossicles (92,2%), while most cases with CSOM atticoantral type had destruction of ossicles (85%).

The majority pattern of hearing loss in CSOM was conductive hearing loss (59%), followed by mixed hearing loss (27%) and sensorineural hearing loss (8%). 5% of cases had normal hearing. This is the same as reported in the literature.<sup>6, 8, 17</sup>

Normal hearing was found in 13 ears (5%), i.e.: 2 with central perforation(without pathological tissue), 4 with total perforation (1 without pathological tissue, 2 with granulation tissues, 1 with cholesteatoma), 2 with marginal perforation (without pathological tissue), and 5 with attic perforation (4 with granulation, 1 with cholesteatoma).

The normal hearing found in the central and marginal perforation without pathological tissue probably due to a small size of perforation (there was no data about the specified size of perforation). In small perforation, hearing loss is only found at low frequenciesso it can result in hearing threshold between normal limit.<sup>9</sup> Granulation tissues / cholesteatoma can become sound conductor media<sup>6, 8, 21</sup>so it also can result in normal hearing threshold.

Most cases with CSOM tubotympanic type had conductive hearing loss (61,17%), some had mixed hearing loss (28,72%), and few had sensorineural hearing loss (5,85%). This is parallel with that reported by Kumar, *et al.*,<sup>7</sup> which showed that most cases had conductive hearing loss (92,18%) and few had sensorineural hearing loss (7,82%).

The majority degree of hearing loss in CSOM tubotympanic type were moderate (34,57%) and mild (19,68%) conductive hearing loss. This is similar to that reported by Kumar, *et al.*,<sup>7</sup> which showed that most of the CSOM patients had mild and moderate hearing loss.

Most cases with CSOM atticofacial type had conductive hearing loss (50,85%), some had mixed hearing loss (23,73%) and sensorineural hearing loss (16,95%). Most of the CSOM atticofacial type cases had moderately-severe conductive hearing loss (22,03%).

The effect of perforation size on the degree of hearing loss was assessed at CSOM cases with central, subtotal or total perforation which had conductive hearing loss. Based on perforation size (central, subtotal, total), there was no increase in the degree of hearing loss with increasing of perforation size. Mild conductive hearing loss was mostly found in cases with central perforation. Moderate conductive hearing loss also was mostly found in cases with central perforation. Moderately-severe conductive hearing loss was found equally in cases with central, subtotal, and total perforation. Severe conductive hearing loss was found in 1 case with central perforation and 1 case with subtotal perforation. Profound conductive hearing loss was found in 1 case with central perforation and 1 case with total perforation. This is not in agreement with the literature which mention that the larger the perforation, the more severe hearing loss caused.<sup>6-8, 10</sup> This is probably due to limited data about site of perforation according to quadrant (anterior/posterior/inferior) and specified size of perforation (small, moderate, large) which also has influence on the degree of hearing loss in CSOM.

Sensorineural hearing loss was mostly found in tympanic membrane perforation cases with cholesteatoma and destruction of ossicles (47,6%). This is in agreement with a study by Kasliwal, *et al.*,<sup>12</sup> which reported that cholesteatoma and destruction ossicles were significantly associated with sensorineural hearing loss.

Sensorineural hearing loss also was found in tympanic membrane perforation cases without pathological tissue (33,28%) and tympanic membrane perforation cases with granulation tissues (19,04%). This is consistent with the literature which mention that sensorineural hearing loss in CSOM can also be caused by mechanical occlusion of oval window due to granulation tissues or pus.<sup>13</sup>

## V. Conclusion

The majority pattern of hearing loss in CSOM was conductive hearing loss, followed by mixed hearing loss and sensorineural hearing loss. Few cases had normal hearing. Normal hearing threshold found in the central and marginal perforation without pathological tissue probably due to the small size of perforation and the role of granulation tissues / cholesteatoma as sound conductor media. Sensorineural hearing loss was mostly found in tympanic membrane perforation cases with cholesteatoma and destruction of ossicles

Most cases with CSOM tubotympanic type had mild and moderate conductive hearing loss. Most cases with CSOM atticofacial type cases also had conductive hearing loss, but with a more severe degree (moderately-severe conductive hearing loss).

Based on perforation size (central, subtotal, total), there was not an increase in the degree of hearing loss with increasing of perforation size. This is probably due to limited data about the site of perforation according to quadrant (anterior/posterior/inferior) and specified size of perforation (small, moderate, large) which also has influence on the degree of hearing loss in CSOM.

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