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Research Article

Hearing Loss Due To Different Types of Impacted Cerumen

Amer Sabih Hydri* and Fatima Siddiqui

Department of ENT/ Head & Neck surgery, PNS SHIFA Hospital, Pakistan

Abstract

Objective: To document change in hearing threshold due to cerumen impaction, in patients having normal hearing.

Study Design: Quasi-experimental study.

Place and Duration of Study: Department of Otorhinolaryngology/Head and Neck Surgery, PNS SHIFA, Karachi; from Nov 2014 to Apr 2015.

Methodology: Initial pure tone audiometry (PTA) of patients with impacted cerumen in either one or both ears was performed. Frequencies 250, 500, 1000,2000,4000,6000 & 8000 Hertz (Hz) were tested. The consistency of cerumen i.e. wet and dry was documented; as was the amount of cerumen within the external auditory canal (EAC). After removal of the cerumen, PTA was repeated over the same frequencies and improvement if any, noted. Data of only those patients, who had normal hearing threshold after removal of cerumen, was consolidated.

Results: Wet cerumen caused considerably more hearing loss in all grades of occlusion compared to dry cerumen.

Conclusion: To standardise the results of further studies on this topic, a uniform classification of the grade of external ear canal occlusion needs to be developed.

INTRODUCTION

Cerumen or earwax is a mixture of secretions i.e. Sebum together with secretions from modified apocrine glands and sloughed epithelial cells present in the external auditory canals of humans [1] and other mammals. Hair and other particulate matter may mix with it as it migrates laterally. Cerumen in normal amounts serves as a self-cleaning agent with protective, lubricating and antibacterial properties. Human earwax consists of wet and dry types. The type of earwax, wet or dry is determined by a single nucleotide polymorphism (SNP)/538G>A (Gly180Arg) in the ABCC gene (ABCC 11) [2]. Dry earwax is prevalent in East Asians, whereas wet earwax is common in other populations worldwide [3].

Cerumen impaction is one of the most common reasons patients seek medical care for ear-related problems [4,5]. Cerumen impaction need not always result in complete obstruction of the external auditory canal. It may either be asymptomatic in some cases, or present in a myriad of presentations e.g. pain [6], itching [7], sensation of fullness, tinnitus, odour, cough, dizziness, failure to adequately examine the tympanic membranes [8] and considerable hearing loss [9,10].

Cerumen impaction puts considerable burden on resources of health services of a country. Prevalence of impacted wax varies considerably e.g. 8.9% [11], 11.7% [12], 19.7% [13] and 20%

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*Corresponding author

Amer Sabih Hydri, Department of ENT/Head & Neck surgery, PNS SHIFA Hospital, Karachi, Pakistan, Tel: 92 344 5253545; Email: draamerhydri@gmail.com

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[14,15]. Impacted cerumen is often difficult to remove [16] and therefore referral to an Otolaryngologist is prudent [17].

Despite several studies on the effects of cerumen impaction and external canal occlusion [18,19] an exhaustive search of the Internet revealed not a single study in which the effect of cerumen impaction was documented in healthy [20] young patients having normal hearing.

We recently conducted a pilot study on 50 young individuals having normal hearing, to document audiometric change in hearing threshold due to cerumen impaction. It was the first one of its kind. The results revealed different levels of hearing loss in wet and dry cerumen even with the same amount of occlusion (Article under publication). This present article is a continuation of the previous study.

METHODOLOGY

This Quasi experimental, double blind study was carried out at the Department of Otorhinolaryngology/ Head and Neck Surgery, PNS SHIFA, Karachi, Pakistan; from Nov 2014 to Sep 2015.

Approval of the protocol of this study was obtained from the hospital Ethical Committee. All the patients enrolled in this study gave Informed consent.

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INCLUSION CRITERIA

Young adults (18-30 years) of both genders having normal hearing (\leq 25 dB) with no history of Psychiatric illness were included in this study.

EXCLUSION CRITERIA

Age less than 18 or more than 30 years.

Patients with a hearing loss even after cerumen removal; (> 25 dB H.L) conductive/sensorineural/mixed type.

External/ Middle ear pathology.

Mentally sub normal individuals or psychiatric patients.

Patients having cerumen in their ears were subjected to otoscopy and only those cases that had total obliteration of tympanic membrane were selected. The primary author examined and assessed the type and quantity of impacted cerumen.

Initial pure tone audiometry of patients with impacted cerumen in either one or both ears was performed. Frequencies 250, 500, 1000,2000,4000,6000 & 8000 Hz were tested. The consistency of cerumen i.e. wet or dry was documented; as was the amount within the EAC. As it is difficult to ascertain the quantity of wet cerumen, especially while removing it with a suction apparatus, the quantity of cerumen occluding the EAC was broadly classified on a scale of 1 to 3 [$1/3^{rd}$ occlusion $2/3^{rd}$ occlusion and 3/3 or complete occlusion of the EAC], not necessarily from within outwards.

Subsequently after removal of the cerumen, PTA was repeated over the same frequencies and any improvement in hearing after cerumen removal was noted. For the sake of convenience, the frequencies tested on PTA were broken down into low (0.25& 0.5 Hz), middle (1&2 KHz) and high (4,6, &8KHz).

Finally, data of 102 patients (129 ears) with normal hearing threshold (0-25 dB), after cerumen removal, was consolidated.

Statistical analysis was performed using 'software package for statistical analysis '(SPSS 20). Paired Student t test was applied for calculating p value; and a value of less than 0.05 considered significant. Mean values were documented as mean SD (standard deviation).

RESULTS

There was a male predominance in our subjects with a Male to Female ratio of 2.3:1

The age ranged from 18-30 years (59.8 %patients were in their 2^{nd} decade (n=61) while 40.2% patients were in their 3^{rd} decade (n=41). Mean age was21.7±3.9 years.

Majority of the patients 73.5 % (n=75) had unilateral cerumen impaction while bilateral cerumen impaction was observed in 26.5 % patients (n=27; ears=54). Out of the former left ear was involved in 68 %(n=51), while the right ear was affected in 32 %(n=24).

In patients having unilateral cerumen impaction, n=75 (75 ears) wet earwax was seen in 52 ears (69.3%) while dry earwax was seen in 23 ears (30.6%). However, in patients having

bilateral cerumen impaction, n=27 (54 ears); dry earwax was seen predominantly i.e., 30 ears (55.5%), while wet earwax was seen in 24 ears (44.4%).

The grade of occlusion in unilateral cerumen impaction, in ascending order of frequency was as follows: $1/3^{rd}$ occlusion (10.6%, n=8), $2/3^{rd}$ occlusion (21.3%, n=16) and 3/3 occlusion (68%, n=51). Overall 26 ears had $1/3^{rd}$ occlusion with an equal distribution of wet and dry cerumen, i.e., 13 ears each.

The most affected frequency was 4 Kilohertz, followed by 6 kilohertz. The mean hearing loss across all affected frequencies was 5 dB.

In the 37 ears having $2/3^{rd}$ cerumen occlusion, dry cerumen outnumbered wet cerumen (21:16). The most commonly affected frequency was 4 Kilohertz followed by 2 kilohertz. The hearing loss ranged from 5-30 dB, with a mean hearing loss of 8.6±1.2 across the affected frequencies.

Sixty-six ears had 3/3 or total occlusion due to cerumen. Wet cerumen paradoxically was predominant (47 ears), as compared to $2/3^{rd}$ -occluded ears. The most commonly affected frequency was 1 Kilohertz followed by 4 kilohertz. The hearing loss ranged from 5-35 dB, with a mean hearing loss of 13.9±0.3 across the affected frequencies (Table 1).

The left ear was more commonly affected in all types of occlusion i.e., 53.8% (14/26 ears) in $1/3^{rd}$ occlusion, 62.16% (23/37 ears) in $2/3^{rd}$ occlusion and 62.1% (41/66 ears) in 3/3 occlusions.

In patients having bilateral cerumen impaction, dry cerumen outnumbered wet cerumen (55.5% vs. 44.4%). The most common combination of grade of occlusion in separate ears of the same individual was $1/3^{rd}$: $2/3^{rd}$ (n=13, 48.1%) followed by 3/3:3/3 occlusion (n=5, 18.5%).

In $1/3^{rd}$ occlusion dry cerumen resulted mainly in hearing loss at 4 and 6 kilo Hz only (high frequencies), while wet impacted cerumen affected all frequencies except 2 kilo Hz.

In the group having $2/3^{rd}$ occlusion; dry cerumen affected hearing mainly at 0.5,2 and 4 kHz (low, middle and high frequencies), while wet cerumen involved all frequencies with minimal involvement of 6 kHz.

Subsequently in 3/3 occlusion both dry and wet cerumen involved all tested frequencies equally (low, middle and high).

In $1/3^{rd}$ occlusion both wet and dry cerumen caused similar hearing loss i.e. $5\pm0~$ dB While in $2/3^{rd}$ and 3/3 occlusion wet

Table 1: Percentage of occlusion and mean hearing loss (in dB).				
Percentage of occlusion of EAC	Mean hearing loss in Dry impacted cerumen	Mean hearing loss in Wet impacted cerumen	Mean Total hearing loss	
1/3 rd	5± 0 dB	5±0 dB	5±0 dB	
2/3 rd	7.7± 0.9 dB	9.5±1.3 dB	8.6±1.2 dB	
3/3	13.7± 3.9 dB	14.2±1.3 dB	13.9±0.4 dB	

Overall mean hearing loss in dry & wet impacted cerumen: 9.2±4.5 dB. **Abbreviations:** dB: Decibel; EAC: External Auditory Canal

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cerumen caused more hearing loss as compared to dry cerumen i.e., 9.5 ± 1.3 dB vs 7.7 ± 0.9 dB and 14.2 ± 1.3 dB vs 13.6 ± 3.9 dB respectively. The severity of hearing loss increased with increasing degree of occlusion.

There was a mean improvement of 9.5±4.6 dB over all frequencies irrespective of percentage of occlusion, after having removed wet impacted cerumen.

On removal of dry impacted cerumen there was a mean improvement of 8.8±4.4 dB over all frequencies irrespective of percentage of occlusion (Table 1).

The mean improvement in hearing threshold over all frequencies in both dry and wet impacted cerumen irrespective of quantity of occlusion was 9.2 ± 0.5 dB.The highest threshold improvement following removal of impacted cerumen was noted in low frequencies(9.5 ± 5.3 dB), followed by (9.2 ± 5.1 dB) in mid frequencies and(8.7 ± 3.3 dB) in high frequencies (Table 2). The maximum improvement in hearing threshold after cerumen removal was 5dB in $1/3^{rd}$ occlusion, 30 dB in $2/3^{rd}$ occlusion and up to 35 dB in total occlusion but not limited to any set of frequencies.

Paired t test was performed on the mean improvement in hearing threshold across low, middle and high frequencies. The 2 tailed p value equals P=0.0007. By convention this difference is considered very statistically significant. The 95% confidence interval was from 8.1379 to 10.2088.

DISCUSSION

The earliest study documenting ear canal occlusion and subsequent hearing loss was conducted by Chandler [21]. He substituted impression material for cerumen and tried to duplicate the occlusion caused by impacted cerumen. Only two subjects were studied. His study showed that when the ear canal is occluded from 80–100%, threshold sensitivity at 2000 Hz and above is systematically reduced by an average of 13–20 dB .Our result of 13.9 dB at the same level of occlusion and frequencies complements his findings.

Pursuing this concept, Roeser [22] used a combination of impression material and a commercial lubricant in order to quantify the effects of varying degree of ear canal occlusion on

Table 2: Hearing loss (in dB) due to grade of impacted cerumen along frequency groups.				
Percentage of occlusion of EAC	Low frequencies 250-500Hz	Mid frequencies 1000-2000Hz	High frequencies 4000,6000,8000Hz	
1/3 rd	5± 0 dB	5± 0 dB	5± 0 dB	
2/3 rd	8.2±1.9 dB	7.9± 0.3 dB	9.7±1.4 dB	
3/3	15.4±2.8 dB	14.9±1.1 dB	11.5±2.7 dB	
Mean hearing loss in all grades of occlusion	9.5±5.3 dB	9.3±5.1 dB	8.7±3.3 dB	
Abbreviations: dB: Decibel; EAC: External Auditory Canal				

pure-tone threshold. His subjects were only 5 normal-hearing adults. He divided occlusion into complete (60-80%) and partial (40-60%) while neglecting less than 40% occlusion. Calculating the exact amount of cerumen occlusion is difficult, owing to the irregular form of cerumen and inability to retrieve the entire amount of cerumen removed e.g. removal by suctioning; we conversely graded the occlusion into $1/3^{rd}$, $2/3^{rd}$ and 3/3 to avoid this pitfall. Furthermore, we computed our results into wet and dry cerumen affecting three sets of frequencies; low, middle and high.

Our results are commensurate in part with his findings i.e. a reduction of threshold sensitivity in all occluded conditions. Roeser noted that frequencies below 1000 Hz were affected only in the completely occluded condition. This is in contrast to our study where wet cerumen even in $1/3^{rd}$ Occlusion affected all tested frequencies except 2000Hz. In $2/3^{rd}$ occlusion; wet cerumen involved all tested frequencies, while dry cerumen mainly affected 500 & 4000Hz.

Both these studies, though detailed in their description, only revealed the results of occlusion by soft semisolid commercial materials, and not actual cerumen occlusion.

A postal survey by Sharp [23] concludes that the removal of occlusive wax improved hearing by a mean of 5 dB over the frequencies analysed. The absence of an accurate grading of cerumen occlusion and any pre-existing hearing loss make these audiological finding tenuous at best.

Williams [24] in a mini review, documented improvement in hearing loss following cerumen removal in a significant number of patients (33%).The reviewer however concludes that these results may be exaggerated and further research may be needed.

Lewis-Cullinan [25] also documented a reversal of hearing impairment following cerumen removal in 75% patients, aged 65 years and older. This population already has a fair amount of hearing impairment, which when compounded with cerumen impaction may exaggerate the hearing loss. In our study there was 100% improvement, as all patients had decreased hearing threshold due to cerumen impaction but otherwise had normal hearing.

Adobamen [11] in his study from Nigeria documented a prevalence of 8.9% (n= 42/471) for cerumen impaction. Majority of his patients (81 %) had mild conductive hearing loss while the rest had mixed hearing loss due to associated sensorineural hearing loss. This verifies our claim that hearing loss purely due to cerumen occlusion can only be assessed accurately in individuals who have normal hearing threshold.

Adegbiji [14] documented that unilateral earwax impaction (75.1%) was more common than bilateral earwax impaction. This is commensurate with our findings of 73.5 %. The contrast to their study was that left ear was affected more than right ear.

Subha [26] computed a mean hearing loss of 21.19dB due to cerumen impaction in his patients ranging from 5-72 years of age. This diverges significantly from our result. Although we did document a maximum hearing loss of up to 35dB in sporadic cases yet our mean was9.2±0.5 dB. This could be due to various factors. Very young patients are known to provide inaccurate response

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in pure tone audiometry, while the geriatric population will have other pre-existing auditory comorbids. On re-testing he included only low and middle frequencies, while we tested all three sets of frequencies, both prior to and following cerumen removal. Our results support his findings that impacted cerumen does cause a significant degree of conductive hearing loss, and that there is no significant correlation between presence of impacted cerumen and variables such as gender or affected side. In a dissimilarity however, we found a positive correlation between the length of the cerumen plug and the severity of hearing loss, but neither consistent nor in all the patients. This may be due in part to the mixed and variable consistency of cerumen and partly due to potential air pockets in the EAC and occluded cerumen, which aid in conduction of sound.

Our study is the first to document the hearing loss due to impacted cerumen in young individuals having normal hearing. This will hopefully generate other large and extensive studies on this topic and we may soon have a standardized criterion of measuring occlusion of an ear canal by cerumen.

CONCLUSION

Our study has highlighted the variable effect of the type of cerumen (Wet & Dry) on hearing threshold. To standardise the results of further studies on this topic, a uniform classification of the grade of external ear canal occlusion needs to be developed.

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