INSERTION AND SUPRA-AURAL EARPHONES: AUDIOLOGICAL ASSESSMENT IN THE ELDERLY

Fones de inserção e fones supra-aurais: avaliação audiológica em idosos

Danielle Tyemi Massukawa Oda [(1)], Andréa Tortosa Marangoni [(2)], Daniela Gil [(3)]

ABSTRACT

Purpose: to investigate the influence of transducer`s type in pure-tone and speech audiometry of elderly in different decades of life. **Methods:** 39 individuals participated in this study of both sexes, aged between 60 and 89 years, selected from the Ambulatório de Audiologia Clínica do Departamento de Fonoaudiologia – UNIFESP, were divided into three groups considering the decade of life (60-69 (G1), 70-79 (G2), 80-89 years old (G3). All individuals have undergone clinical history, pure-tone and speech audiometries which were performed with both supra-aural TDH-39 and ER-3A insert earphones. The results were statistically analyzed with the ANOVA and T-Student Pareado tests in order to compare the performance of the subjects with different transducers in groups and between age groups. **Results:** statistical analysis performed by ear and by group revealed lower hearing thresholds with ER-3A earphones with statistical significance in the frequencies of 4 and 6 kHz. Comparing age groups, poorer thresholds were obtained in the oldest subjects independent of the transducer. The older the subject, the poorer the thresholds independent of the transducer. Word recognition score showed better results with insert earphones and worsened with increasing age. **Conclusion:** insert earphones (ER-3A) provide better hearing thresholds compared to supra-aural headphones (TDH-39) at regardless of age. A progressive decrease in hearing and also in word recognition score result from increasing age.

KEYWORDS: Presbycusis; Aging; Hearing Aids

INTRODUCTION

Aging is a natural phenomenon in which sensory-perceptual abilities tend to decline leading to possible changes in communication between individuals. Over the years, individuals undergo changes in their body, causing difficulties in their daily lives and interfering in social life.

One of the influences of the aging process is presbycusis, which is characterized by a progressive deterioration of hearing due to physiological and degenerative variations in the auditory system resulting from aging which may be aggravated by exposure to loud noises, medical agents, genetic predisposition, metabolic disorders, vascular disorders, kidney disease and daily stress [1-3].

Presbycusis usually leads to a bilateral senso-rineural hearing loss with sloping and symmetrical curve at the audiogram. High frequencies are the most affected causing damage in identifying treble and thus in speech recognition, especially when the speech rate is fast or when the environment is noisy. Furthermore, the acoustic signals take longer to be processed [2,4].

In audiology, hearing thresholds can be obtained by using three types of phones, namely: supra-aural, circum-aural and insert earphones[5,6].

(1) Universidade Federal de São Paulo – Escola Paulista de Medicina/UNIFESP, São Paulo, SP, Brazil.

(2) Universidade Federal de São Paulo – Escola Paulista de Medicina, São Paulo, SP, Brazil.

(3) Department of Speech of Universidade Federal de São Paulo – Escola Paulista de Medicina/UNIFESP, São Paulo, SP, Brazil.

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The circum-aural phones are headphones that are positioned around the ear pinna. Thus, there is no pressure of the headset cushion to the ear pinna, resulting in greater comfort for the patient. However, the lack of standardization in methods of calibration limits its use in audiological routine [7].

Supra-aural earphones are conventional transducers in clinical audiology, in which the headset cushion is pressed against the pinna. As a disadvantage, the supra-aural headphones present poor reliability at low frequencies [8].

Insert earphones are adapted to the external auditory canal (EAC) using disposable foam plugs, providing a reduction in the response by vibration, increase of interaural attenuation and significant reduction in the risk of collapse of the EAC [9].

When compared to supra-aural headphones, insert earphones produce less pressure on the ear pinna and the skull, are more comfortable, generate greater reliability in the examination, present greater interaural attenuation and can reduce or eliminate the need for contralateral masking [10], promote greater attenuation of ambient noise, allowing the accomplishment of audiometric tests in non sound-proof places [11], diminish the effect of occlusion of the EAC in testing bone conduction and reduce the risk of collapse of the EAC [9,12-14].

The collapse of the EAC may occur at any age, but about a third of the patients in which this phenomenon occurs is elderly. These patients may have unusually small and narrow EAC openings, protruding ears, large and drooping ears. To avoid collapse during the audiometric test, it can be inserted a polyethylene tube of small diameter inside the external auditory meatus or an olive used in immittanciometry [15,16], use of filler (gauze, for example) strongly curled on the back of of the ear pinna, before placing the headset, maintenance of supra-aural headphones in light contact with the ear, use of free-field audiometry and use of ear mold. However, one of the most effective solutions is the use of insert earphones [17].

Facing the shortage of research on the use of insert earphones involving elderly subjects, the aim of this study is to investigate the influence of the type of transducer in tonal and vocal audiometry of elderly people in different decades of life.

METHODS

This is a cross-sectional study in which the procedures were performed at the Clinical Audiology institution.

For this study, 39 subjects of both sexes were selected from the following inclusion criteria:

1. Age over 60 years [18];
2. bilateral type A tympanograms;
3. Absence of apparent neurological and/or cognitive problems.

The subjects were divided into three groups separated by decades of life from the age of 60, namely: between 60 and 69 years (G1), between 70 and 79 years (G2) and between 80 and 89 years (G3), being 13 participants in each group and they underwent the following procedures:

A) Anamnesis: Questions about the identification of the subject, the reason for the consultation; hearing, otologic and medical histories and about the medicine use were performed.

B) Meatoscopy: Was performed to verify the conditions of the external auditory meatus. If unable to attend, as stopper wax and/or presence of foreign body, the elderly was referred to ear washing and a return was scheduled after its execution.

C) Pure tone audiometry – Air conduction (AC) and bone conduction (BC): in order to obtain thresholds by air and bone conduction, the examiner gave the instructions to the subject clearly and briefly, to ensure understanding of the procedures. In testing the air way, headphones were placed and the procedure was initiated by the better ear reported by patients in the frequency of 1000Hz. The pure tone stimulus was presented in an audible intensity, and the subjects were instructed to raise their hands when they heard the stimulus, even at low intensity. The intensity was decreased in steps of 10 dB until the patient did not perceive the stimulus. At that moment, the intensity was increased in steps of 5dB until the patient responded again and the hearing threshold was considered as the lowest intensity at which the subject responded to two of four presentations (50% of the time at least). After the initial frequency of testing, the same procedure was repeated at frequencies of 2000, 3000, 4000, 6000, 8000, 500 and 250 Hz in this order in both ears.

The bone conduction thresholds were obtained at 500, 1000, 2000, 3000 and 4000 Hz, using the same procedure described for the AC. The bone vibrator was placed on the mastoid of the ear to be tested region. At the opposite ear, masking was used for the Narrow Band (NB) noise [19,20].

For use of the ER-3A insert earphones in equipment calibrated to the supra-aural and/or without automatic conversion headphones, the equipment manufacturer has recommended the use of correction factors to be added to the hearing threshold as described below [21].

125	250	500	750	1,000	1,500	2,000	3,000	4,000	6,000	8,000	Hz
15	5	0	0	5	0	5	5	0	-10	-10	dB

Speech audiometry:

D) SRT (Speech Reception Threshold): Subjects were instructed to repeat the words presented by the examiner in the microphone. Initial intensity was 40dBSL from the average of 500, 1000 and 2000Hz and for every word correctly repeated the intensity was decreased in steps of 10dB. At the time that the individual did not repeat correctly, other three words were presented at the same level. If the patient did not hit 50% of the words, the intensity was increased by 5 dB. The speech reception threshold was considered when the subject hit at least 50% of the words presented [20,22].

E) WRS (Word Reconginiton Score): The test was performed at 40 dB above the average of 500, 1,000 and 2,000 Hz and the subject was asked to repeat a list of 25 monosyllabic words [23] in each ear, presented through speakers. For each hit, were accounted 4%, with a total of 100%. The result was considered normal when the percentage of correct answers reached 88-100%. If the percentage of correct answers were lower, a list of two-syllable words was presented [19,20,22].

Both the audiometry by AC, as speech audiometry were performed first with the supra-aural headphones (TDH-39) and later with insert earphones.

This study was reviewed and approved by the Ethics Committee in Research of the Universidade Federal de São Paulo, with the protocol number 1186/10. All participants signed a consent form.

Results of this research were analyzed using the paired Student's *t*-test, which is also known as the Test of Equality of two means, for it assumes that the population variances are unknown and, accepted equal, independent and normal. This test was used to compare the right ear (RE) with the left ear (LE) in each variable per group, for both the ER-3A insert earphone as for the supra-aural TDH-39 and to compare ER-3A with the TDH-39 in each group. Furthermore, the same test was used to compare the results obtained at each frequency with the two transducers for the three age groups. For this study, the significance level was set at 0.05 (5%) for all confidence intervals and were constructed with 95% of statistical confidence.

RESULTS

Through Table 1 it can be seen that the ER-3A insert earphone led to better hearing thresholds at frequencies of 250, 500, 2000, 4000, 6000 and 8000 Hz in most groups representing the age group of 60-89 years. With supra-aural TDH-39 earphone, there were better hearing thresholds at frequencies 1000 and 3000 Hz in the 3 groups studied.

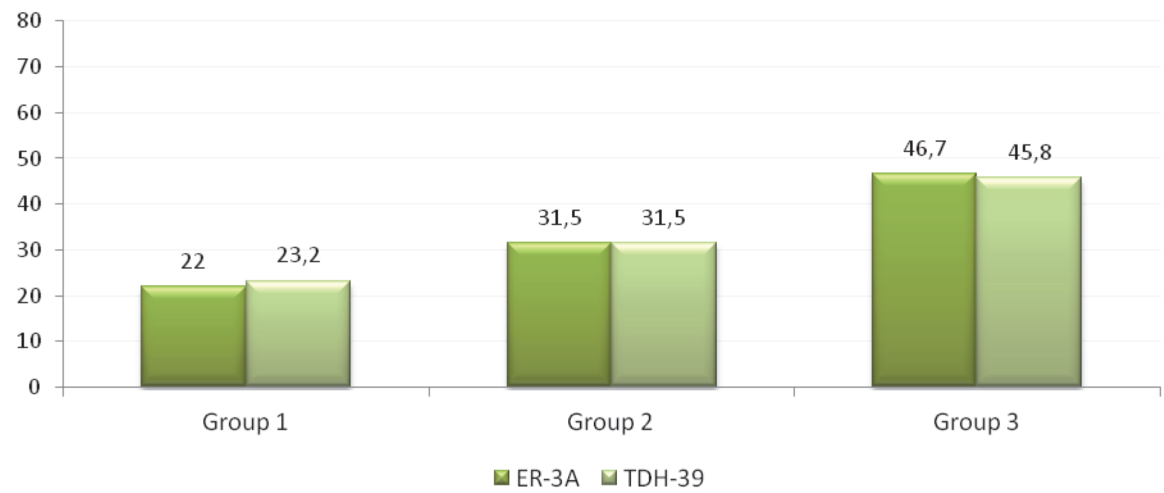
The results showed that the groups did not differ significantly on the SRT.

Through the ANOVA test, which was used to compare the mean score in WRS in the three groups, there were differences between the results obtained with the two transducers, and the ER-3A earphone provided better performance in all groups, and this difference was statistically significant at all groups.

Table 1 – Descriptive measures of auditory thresholds at frequencies from 250 to 8000Hz according to age group and type of transducer

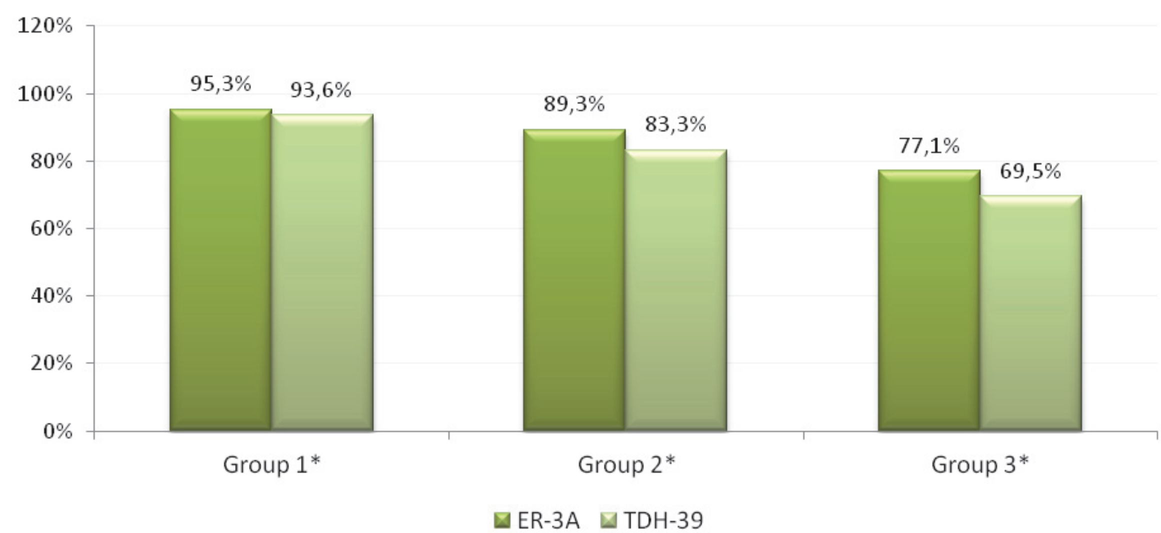
250 Hz	Grupo 1	ER-3A	14,5	15	7	5	35	30	2,5	0,002
		TDH-39	18,7	20	9,6	5	50	30	3,5	
	Grupo 2	ER-3A	21,7	20	11	0	40	30	3,9	0,607
		TDH-39	22,8	25	6,8	5	35	30	2,4	
	Grupo 3	ER-3A	26,7	25	17,5	5	80	26	6,7	0,068
		TDH-39	30,4	25	15,4	10	70	26	5,9	
500 Hz	Grupo 1	ER-3A	17,5	15	8,7	0	35	30	3,1	0,125
		TDH-39	19,2	18	9,8	5	45	30	3,5	
	Grupo 2	ER-3A	23,8	25	9,8	0	40	30	3,5	0,252
		TDH-39	25,5	25	7,5	15	40	30	2,7	
	Grupo 3	ER-3A	33,3	35	17,2	5	75	26	6,6	0,816
		TDH-39	33,7	30	15,5	10	70	26	6	
1000 Hz	Grupo 1	ER-3A	22,5	20	9,5	10	45	30	3,4	<0,001
		TDH-39	19,2	15	10,1	5	45	30	3,6	
	Grupo 2	ER-3A	29,5	30	12,9	5	55	30	4,6	0,662
		TDH-39	29	28	11,4	15	50	30	4,1	
	Grupo 3	ER-3A	42,5	43	16,3	15	80	26	6,3	0,080
		TDH-39	39,4	40	13,1	20	70	26	5	
2000 Hz	Grupo 1	ER-3A	22,3	20	9,3	10	45	30	3,3	0,420
		TDH-39	21,5	20	9,8	5	40	30	3,5	
	Grupo 2	ER-3A	32,5	30	13,4	15	60	30	4,8	0,363
		TDH-39	33,5	30	13,1	15	60	30	4,7	
	Grupo 3	ER-3A	50,6	50	11,5	30	75	26	4,4	0,760
		TDH-39	51,2	50	13,6	25	90	26	5,2	
3000 Hz	Grupo 1	ER-3A	27,5	25	13,1	10	60	30	4,7	0,002
		TDH-39	22,8	20	15,8	0	60	30	5,7	
	Grupo 2	ER-3A	38,3	35	16,8	10	80	30	6	0,698
		TDH-39	37,8	40	17,8	10	75	30	6,4	
	Grupo 3	ER-3A	57,1	55	16,6	35	105	26	6,4	0,563
		TDH-39	55,8	55	21,3	25	110	26	8,2	
4000 Hz	Grupo 1	ER-3A	26,7	25	13,7	5	55	30	4,9	0,203
		TDH-39	28,5	25	17,4	5	70	30	6,2	
	Grupo 2	ER-3A	36	38	17,9	0	75	30	6,4	<0,001
		TDH-39	43,3	50	21	5	85	30	7,5	
	Grupo 3	ER-3A	55,4	55	16	30	100	26	6,1	0,103
		TDH-39	59,4	60	21,7	25	110	26	8,4	
6000 Hz	Grupo 1	ER-3A	35,3	35	18,4	10	85	30	6,6	0,004
		TDH-39	41,2	38	21,7	10	85	30	7,8	
	Grupo 2	ER-3A	48,7	50	18,8	10	85	30	6,7	<0,001
		TDH-39	54,7	58	17,1	15	85	30	6,1	
	Grupo 3	ER-3A	62,9	65	14,8	30	95	26	5,7	0,030
		TDH-39	69,2	70	17	35	110	26	6,5	
8000 Hz	Grupo 1	ER-3A	38,7	38	20,7	5	85	30	7,4	0,813
		TDH-39	39,2	35	22,3	0	85	30	8	
	Grupo 2	ER-3A	57,8	63	17,9	15	80	30	6,4	0,600
		TDH-39	58,7	60	19,8	15	85	30	7,1	
	Grupo 3	ER-3A	67,7	70	16	20	90	26	6,2	0,027
		TDH-39	73,8	75	13,6	45	100	24	5,4	

Notes: ■ Statistically significant values; ■ Values with statistically significant tendencies
Statistical test: Paired Student's *t*-test (p<0.05)



Notes: ER-3A earphone; TDH-39 headphone
Statistical test: ANOVA ($p<0.05$)

Figure 1 – Comparison between ER-3A and TDH-39 earphones in SRT



Notes: ER-3A earphone; TDH-39 headphone
Statistical test: ANOVA ($p<0.05$)

Figure 2 – Comparison between ER-3A and TDH-39 earphones in WRS

DISCUSSION

With the presented table it was possible to verify that the ER-3A insert earphone at frequencies of 250, 500, 4000, 6000 and 8000 Hz, in the three age groups, allowed obtaining auditory thresholds. On the other hand, with the supra-aural TDH-39, the frequencies of 1000 and 3000Hz had their thresholds below the ones found with the ER-3A earphone, and the minimum difference was found in the frequency of 1000Hz in Group 2. In the frequency of 2000Hz, only Group 1, comprising the age group between 60-69 years, showed better results with TDH-39. Groups 2 and 3 had lower thresholds with the ER-3A earphone.

As noted, the ER-3A earphones provided better thresholds at lower and higher frequencies. This finding may be due to the use of foam plugs which, when inserted deeply, prevent the collapse of the external auditory canal, which may compromise the attainment of thresholds by air, especially in elderly individuals [13]. Furthermore, factors such as the size and geometry of the external auditory canal of men and women could justify differences in thresholds obtained with insert earphones, for when considering that the external auditory canal of women is smaller and shorter than men, the residual space of the ear canal after insertion of the foam plug is also lower in women, which would help to decrease the amount of physiological noise in this space, and thus enable the attainment of lower thresholds. Finally, the use of insert earphones allows greater attenuation of external noise, reflected in lower auditory thresholds [8-12,21-27].

For the SRT (Speech Reception Threshold) represented by Figure 1, the performance was similar among the phones, as in Group 1 the ER-3A enabled the lowest threshold for speech reception; Group 2 showed no difference between the phones and the Group 3 reached the lowest value with the TDH-39 headphone. But these values were not significant in the comparison between the transducers in all age groups. This fact can be explained by the standard of review of the SRT, which can range up to 10 dB above the tone average of thresholds at 500, 1000 and 2000Hz. For this reason, the SRT showed similar values in the comparison between the transducers, since that for both transducers the SRT was compatible with the audiometry. Some authors believe that the insert earphone promotes greater attenuation of ambient noise, resulting in improvement of speech recognition [12-14].

The WRS (Word Recognition Score), represented by Figure 2, had a higher percentage of correct answers with the insert earphone in all three groups, probably due to less interference of external noise that this phone provides, as already observed in other studies [11,22]. In the averages of Group 3 there was a difference higher than 6%, being this group the one with greater range, comprising between ages 80-89 years. In some studies [9,27,28] the authors agreed with the findings, because besides the fact that the insert earphone minimizes external noise through the deep insertion of the plug, it also increases interaural attenuation and decreases the occlusion effect, providing more reliable results.

The WRS proved to be progressively worse in relation to increasing age, consistent with pure tone audiometry, being considered normal in Groups 1 and 2 and altered in Group 3 by presenting results lower than 88% of accuracy.

With the progression of the hearing loss it can be observed that the Word Recognition Score in the elderly presented changes with increasing age, showing that the higher the age, the worse the speech discrimination, regardless of the type of phone used. These findings are similar to other studies [29-36], contributing to the understanding of presbycusis, generally speaking, and how it affects this population.

CONCLUSION

From the analysis of the results it can be concluded that insert earphones (ER-3A) enable the achievement of better hearing thresholds if compared to the supra-aural headphones (TDH-39) at frequencies of 250, 500, 1000, 4000, 6000 and 8000 Hz regardless the age and, the higher the age, the worse hearing thresholds are.

For the SRT, there is no difference between the transducers independently of age range.

WRS presents the best answers with insert earphone and is progressively worse the older the individual is, regardless of the transducer.

RESUMO

Objetivo: verificar a influência do tipo de transdutor na audiometria tonal e vocal de idosos em diferentes décadas de vida. **Métodos**: 39 indivíduos de ambos os sexos, com idade entre 60 e 89 anos, selecionados no Ambulatório de Audiologia Clínica do Departamento de Fonoaudiologia da UNIFESP, foram divididos em três grupos etários 60-69 (G1), 70-79 (G2), 80-89 anos (G3). Todos os pacientes foram submetidos a anamnese audiológica, meatoscopia e avaliação audiológica básica, sendo que a audiometria tonal liminar e a logoaudiometria foram realizadas tanto com os fones supra-aurais TDH-39 quanto com os fones de inserção ER-3A. Os resultados foram analisados estatisticamente com os testes ANOVA e T-Student Pareado. **Resultados:** a análise estatística realizada por orelha e por grupo revelou limiares auditivos mais baixos com os fones ER-3A com significância estatística nas frequências de 4 e 6KHz. Na comparação entre os grupos etários, verificou-se que quanto maior a idade, piores os limiares, independente do transdutor. O Índice Percentual de Reconhecimento de Fala apresentou maiores porcentagens de acertos com o fone ER-3A e houve piora do desempenho com o aumento da idade, com ambos os transdutores. **Conclusão**: os fones de inserção (ER-3A) possibilitam a obtenção de melhores limiares de audibilidade se comparados aos fones supra-aurais (TDH-39) independente da idade. Em decorrência do aumento da idade, há a diminuição progressiva da audição refletida tanto nos limiares de audibilidade como no reconhecimento de fala.

DESCRITORES: Presbiacusia; Envelhecimento; Auxiliares de Audição

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Mailing address:
Danielle Tyemi Massukawa Oda
Avenida Pedro de Souza Lopes, 67 – Vila Galvão
Guarulhos – SP
CEP: 07074-000
E-mail: tyemizinha@gmail.com