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Original Article

Artigo Original

Interaction between *diabetes mellitus* and hypertension on hearing of elderly

Interação entre diabetes mellitus e hipertensão arterial sobre a audição de idosos

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Keywords

Hearing
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ABSTRACT

Introduction: Chronic diseases and metabolic changes may act as accelerating factor in the degeneration of the auditory system due to age. However, studies involving an association between hearing loss and *diabetes mellitus* (DM) and hypertension (HA) in the elderly have shown controversial conclusions. Thus, further studies on this topic are needed in order to elucidate the effect of these chronic diseases on the auditory system. **Aim:** To compare the hearing thresholds of elderly patients with DM, HA and DM + HA with a control group (CG). **Methods:** Retrospective study was conducted through survey charts of 80 elderly people with full hearing assessment, between 2008 and 2012. Subjects were divided into four groups: DM, HA, DM + HA and without chronic diseases known (CG). The ANOVA, Tukey and Mauchly tests, with a significance level of 0.05, were used. **Results:** There was no statistically significant difference between the ears, which are grouped. Comparisons between the means of hearing thresholds of CG and DM or HA showed no statistically significant differences. However, a statistically significant difference in the comparison between these three groups and DM + HA group for several of the frequencies evaluated was observed. **Conclusion:** It was found that older adults with DM and hypertension associated showed greater hearing impairment in comparison with the other groups, suggesting a synergistic effect of the two chronic diseases on hearing.

Descritores

Audição
Diabetes Mellitus
Hipertensão Arterial
Perda Auditiva
Idoso

RESUMO

Introdução: Doenças crônicas e alterações metabólicas podem atuar como fator de aceleração na degeneração do sistema auditivo decorrente da idade. No entanto, estudos envolvendo a associação entre a perda auditiva com a *diabetes mellitus* (DM) e com a hipertensão arterial (AH) em idosos mostraram conclusões controversas. Sendo assim, novos estudos sobre essa temática são necessários, a fim de elucidarmos o efeito dessas doenças crônicas sobre o sistema auditivo. **Objetivo:** Comparar os limiares auditivos de idosos portadores de DM, de AH e de DM+AH com um grupo controle (GC). **Métodos:** Estudo retrospectivo realizado por meio de levantamento de prontuários de 80 idosos com avaliação audiológica completa, entre 2008 e 2012. Os idosos foram distribuídos em quatro grupos: portadores de DM, portadores de AH, portadores de DM+AH e sem doenças crônicas conhecidas (GC). Foram utilizados os testes estatísticos ANOVA, Tukey e Mauchly, com nível de significância de 0,05. **Resultados:** Não houve diferença estatisticamente significante entre as orelhas, sendo esses resultados agrupados. As comparações entre as médias dos limiares auditivos dos grupos GC e DM ou AH não mostraram diferenças estatisticamente significantes, entretanto houve diferença estatisticamente significante na comparação entre esses três grupos e o grupo DM+AH para várias das frequências da audiometria avaliadas. **Conclusão:** Verificou-se que idosos com DM e AH associados apresentaram maior comprometimento auditivo com relação aos outros grupos, sugerindo um efeito sinérgico das duas doenças crônicas sobre a audição.

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INTRODUCTION

Population aging is now taking place around the world, determining the larger growth of the elderly population in comparison to other age groups[1]. Aging is related to the process of progressive degeneration and cell death, leading to the decreased functional capacity of the body[2].

Hearing loss resulting from the aging process is known as presbycusis, characterized by the bilateral reduction of hearing acuity, generally for high frequency sounds, due to degenerative and physiological changes in the auditory system that come with age. This is the most common sensory impairment affecting the elderly, with prevalence ranging from 20 to 40%. It determines many implications, such as decreased speech perception, psychological disorders and social isolation, thus having a negative impact on the quality of life of the individual[3].

Studies show that chronic diseases that affect the elderly population may be related to hearing changes[4-6]. The most frequent ones are diabetes mellitus and arterial hypertension.

Diabetes mellitus (DM) is a metabolic dysfunction characterized by hyperglycemia, and can be a result of dysfunctions both in the action and in the secretion of insulin, or in both. Studies indicate that the prevalence of DM ranges from 7 to 14% in the population aged 30 to 69 years old[7].

Hearing loss in individuals with DM can be related to diabetic angiopathy, which interferes in the nutrient and oxygen supply in the cochlea, leading to cell and tissue death[6,8]. Besides cochlear changes, it is believed that DM can cause secondary degeneration of the eighth cranial nerve, causing neural hearing loss[6].

Systemic arterial hypertension (AH) is a multifactorial clinical condition called a syndrome and characterized by the presence of high tension levels, associated with metabolic and hormone changes and with trophic phenomena (cardiac and vascular hypertrophy)[9].

AH can contribute with the appearance of other diseases, such as kidney failure, aneurism, heart failure, stroke or myocardial infarction. These vascular changes compromise the normal irrigation of the body, and consequently, they also affect its functional integrity, leading to organ impairment, including the auditory system[10].

In Brazil, it is estimated that approximately 25% of the population has AH[11]. Even though some studies have investigated the association between hearing loss with DM or with AH among the elderly population, their conclusions are controversial, and such an association is not established yet; further studies are required on the matter. The hypothesis of this study is that chronic diseases, such as DM and AH, are factors that aggravate presbycusis.

Therefore, the objective of this study was to compare the hearing thresholds of elderly people with DM or AH, as well as DM associated with AH, with a control group (with neither of the conditions).

METHODS

This study was approved by the Research Ethics Committee of the University Hospital at Universidade de São Paulo, n. 883/09.

The study was carried out in the Laboratory of Speech Language Pathology Investigation and Primary Care in Audiology at the School of Medicine of Universidade de São Paulo, and in the Audiology Service of the University Hospital (UH) of Universidade de São Paulo.

This was a retrospective study conducted by surveying data from medical records of individuals who underwent a hearing test at the UH between 2008 and 2012.

The following inclusion criteria were established: being 60 years old or older and having complete hearing assessment (anamnesis, pure tone audiometry, vocal audiometry and acoustic immittance measurements). Besides, it was necessary to present: diabetes mellitus to be included in the DM group; systemic arterial hypertension, for the inclusion in the AH group; and DM associated with AH for the inclusion in the group DM + AH.

Therefore, 80 medical records were selected: 20 elders with no metabolic changes, constituting the control group (CG); 20 elders with DM; 20 elders with AH; and 20 elders with DM + AH.

For the statistical analysis, besides the descriptive measures, the following tests were used: the repeated measures ANOVA and the Tukey's test. To verify the circularity assumption in the variance and covariance matrix, the Mauchly's test was used. For the tests of hypotheses, a 0.05 significance level was established.

RESULTS

Table 1 presents the values referring to the mean age of the participants in each group. Even though the mean age in each group is not the same, there was no statistically significant difference between groups (p=0.080).

Table 1. Mean age (in years) for the CG, DM, AH and DM+AH groups.

Groups	n	Mean	Standard deviation
CG	20	70.55	4.8
AH	20	68.65	5.9
DM	20	71.00	6.8
DM+AH	20	72.17	8.0

Caption: CG = Control Group; AH = Group of elders with arterial hypertension; DM = Group of elders with *diabetes mellitus*; DM+AH = Group of elders with *diabetes mellitus* and arterial hypertension

By comparing the means of hearing thresholds between both ears, a p value of 0.07 was obtained. This conclusion was independent of group (p=0.976) or frequency (p=0.504). Since there was no significant difference between the ears, they were grouped for the following comparisons.

Afterwards, a comparative analysis was conducted between the means of hearing thresholds for each frequency between the CG, DM, AH and DM + AH.

It is worth to mention that all participants, from all groups, presented with sensorineural hearing loss in at least one of the assessed frequencies, with the descending audiometry.

Table 2 describes the analyses that showed statistically significant differences between groups for all of the assessed frequencies. The Tukey's test, represented in the last column of the table, indicated which comparisons presented statistically significant differences.

Table 2. Comparison of the mean hearing thresholds (in dBHL) of the frequencies from 250 to 8.000 Hz between groups

Frequency (Hz)	Mean (in dBHL)	Standard deviation	p-value	Tukey's test
250				
CG	16.12	8.6	<0.0001	CG X DM+AH – p<0.01
AH	19.12	10.6		AH X DM+AH – p<0.01
DM	16.75	8.0		DM X DM+AH – p<0.01
DM+AH	28.12	12.6		–
500				
CG	15.62	8.7	<0.0001	CG X DM+AH – p<0.01
AH	20.12	11.1		AH X DM+AH – p<0.01
DM	17.12	10.4		DM X DM+AH – p<0.01
DM+AH	30	14.9		–
1.000				
CG	19.12	13.3	<0.0001	CG X DM+AH – p<0.01
AH	19.87	9.0		AH X DM+AH – p<0.01
DM	21.25	16.2		DM X DM+AH – p<0.01
DM+AH	33	16.9		–
2.000				
CG	23	16.1	0.003	CG X DM+AH – p<0.01
AH	25.25	12.5		AH X DM+AH – p<0.05
DM	25.62	19.5		DM X DM+AH – p<0.05
DM+AH	35.5	15.4		–
3.000				
CG	29.5	16.1	0.008	CG X DM+AH – p<0.05
AH	28.75	14.7		AH X DM+AH – p<0.05
DM	32.25	19.8		–
DM+AH	40.75	18.2		–
4.000				
CG	35.5	15.8	0.014	–
AH	33.75	14.6		AH X DM+AH – p<0.05
DM	39.37	19.2		–
DM+AH	45.62	19.6		–
6.000				
CG	43.8	15.6	0.003	CG X DM+AH – p<0.05
AH	44.3	17.4		AH X DM+AH – p<0.05
DM	42.7	20.12		DM X DM+AH – p<0.01
DM+AH	56	18.61		–
8.000				
CG	47.62	15.9	0.002	–
AH	49.87	18.0		–
DM	42.5	21.8		DM X DM+AH – p<0.01
DM+AH	58.12	18.4		–

Caption: CG = Control group; AH = Group of elders with arterial hypertension; DM = Group of elders with *diabetes mellitus*; DM+AH = Group of elders with *diabetes mellitus* and arterial hypertension

Figure 1 represents the hearing thresholds of the groups for the groups ears, helping to visualize the data indicated in Table 2. It is possible to observe that the CG has better hearing thresholds for some frequencies (250 to 2.000 Hz). For other frequencies, the AH and DM groups had worse hearing thresholds, when compared to the thresholds of the two other groups. That is, the AH group presented worse hearing thresholds at 250, 500, 6.000 and 8.000 Hz in comparison to the CG and the DM groups; and the DM group presented worse hearing thresholds from 1.000 to 4.000 Hz, when compared to the CG and to the AH groups. As to the DM + AH group, we observed significantly worse hearing thresholds for all frequencies in comparison to the three other groups.

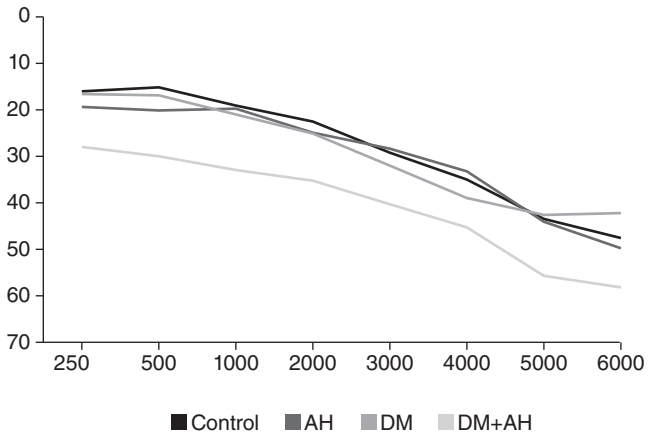

Figure 1. Mean of hearing thresholds (in dBHL) for frequencies from 250 to 8.000 Hz per group.

DISCUSSION

The objective of this study was to compare the hearing thresholds of elderly people with DM, AH and DM associated with AH, with a control group, to verify the presence of comorbidity between hearing loss and DM and/or AH.

With regard to the age of the participants, there was no statistically significant difference related to the mean ages of the studied groups. Therefore, we can suggest that the age was similar between the four groups, so this factor did not specifically interfere in one group.

Since there were no significant differences between the ears, they were grouped. The fact that there were no differences between the right and the left ears was expected, since both presbycusis and systemic changes affect the body as a whole, thus leading to symmetrical hearing loss in both ears[3].

It is important to mention that all participants, in every group, presented sensorineural hearing loss in at least one of the assessed frequencies.

These findings indicate that even the individuals who do not present associated changes (DM and/or AH) had some level of impairment in the auditory system, possibly caused by aging, showing presbycusis, which is common at this age group. It has been described in the literature that hearing loss in the elderly population increases with age. The prevalence

of hearing loss increases 40% between the ages of 70 and 74, and 50% for people older than 75 in relation to the ages of reference (65–69 years old)[12].

Concerning the audiometric configuration, a descending curve was observed, with worse hearing thresholds at the highest frequencies. This fact had already been described and expected for presbycusis[13,14].

Besides, there are reports in the literature demonstrating that elders with associated hearing loss and DM usually present sensorineural hearing loss, especially at high frequencies[6,15-17]. As to AH, some studies showed flat hearing loss, affecting low, medium and high frequencies[18].

When the mean hearing thresholds were compared between groups, it was observed that the CG presented better hearing thresholds for some frequencies (250 to 2.000 Hz), however, there was no statistically significant difference in the comparison with the AH and DM groups.

For the other frequencies, it was verified that the AH and DM groups presented worse hearing thresholds in comparison to the two other groups, that is, the AH group presented worse hearing thresholds at 250, 500, 6.000 and 8.000 Hz in comparison to the CG and to the DM; and the DM group presented worse hearing thresholds between 1.000 and 4.000 Hz, in comparison to the CG and to the AH, however, with no statistically significant difference.

Regarding the DM and AH groups, which presented worse hearing thresholds than the CG, the results were in accordance with some studies in literature, which will be mentioned next.

With regard to DM, several authors have found an association between the presence of diabetes and hearing impairment, describing different levels of bilateral sensorineural hearing loss, especially at high frequencies[5,6,15-17].

It is believed that one of the causes of hearing loss in individuals with DM is diabetic angiopathy, which is the diffuse thickening of the basement membranes and the vascular endothelium. Angiopathy can directly interfere in the nutrient and oxygen supply in the cochlea, because of the reduced transportation caused by the thickening of the capillary walls. It can also interferes indirectly due to the reduced flow caused by vascular narrowing, leading to the death of cells and biological tissue. Therefore, tissues that are very sensitive to oxygen levels develop microangiopathy[6,8].

Besides cochlear changes, DM is believed to cause secondary degeneration of the eighth cranial nerve, leading to neural hearing loss. Hearing loss can also be cause by diabetic neuropathy, which affects 60 to 70% of people with diabetes. It is characterized as an auditory nerve lesion, because of high glycemic levels[6].

Regarding AH, some studies also found a positive association with hearing loss[4,19-21]. Besides, it was suggested that AH could work as an accelerating factor for the degeneration of the auditory system[4].

AH affects the proper supply of oxygen and nutrients to the cell. This supply depends on the functional and structural integrity of the heart and the blood vessels[19]. So, AH can affect the physiological mechanisms of the inner ear by the increased blood viscosity, leading to decreasing capillary blood flow and oxygen transportation[22].

Regarding the DM+AH group, we observed significantly worse hearing thresholds for all of the assessed frequencies in comparison to the three other groups (CG, AH and DM). This fact suggests that the association between both pathologies may have a synergistic effect on the hearing of the elderly, that is, there is a cooperative action of the conditions on the body that makes their effect stronger than the sum of the effects of each condition alone[23].

These findings corroborate those in the study by Duck et al[24], who conducted a clinical study and an animal study regarding hypertension associated with diabetes and observed, respectively, sensorineural hearing loss at high frequencies (even if using age correction factors) and adverse effects on the cochlea, leading to the loss of hair cells.

The results of this study show the need to analyze and monitor the hearing conditions of patients with DM, AH and especially patients with both diseases, once they are part of a population with higher risk of presenting hearing changes. Besides, it is important to mention that the chances of hearing rehabilitation are higher if these changes are detected early.

Limitations of the study

In this study, the comparison between the hearing thresholds of the CG, AH and DM with no statistically significant difference does not mean that the elders with AH or DM cannot present greater hearing impairment in comparison to elderly people without these changes. The sample of the three groups is small; perhaps if this comparison was made with larger group, the differences between the hearing thresholds would be clearer.

Besides, it is important to consider the time of disease onset, once it is expected that individuals who have had the disease for longer will present greater hearing impairment, because of the physiopathological mechanisms of DM and AH. Therefore, we suggest that further studies consider this variable for the comparisons.

The medication used by the individuals, as well as the control of each of the diseases, should also be investigated, since they can have an impact on hearing impairment.

CONCLUSION

Generally, the elderly in the CG presented better hearing thresholds than the other groups. However, statistically significant differences have only been verified for the comparison of the CG, DM and AH groups with the DM+AH group, showing that elders with associated DM and AH presented greater hearing impairment in relation to the other groups, suggesting that these two changes can have a synergistic effect on hearing.

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