

Teste GIN (*Gaps-in-Noise*) em ouvintes normais com e sem zumbido*****

GIN Test (*Gaps-in-Noise*) in normal listeners with and without tinnitus

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Abstract

Background: the *Gaps-in-Noise* (GIN) test assesses the auditory temporal resolution skill. Studies have described the GIN test an instrument of easy application and with good sensitivity and specificity. **Aim:** to compare the results of the GIN test in normal listeners with and without tinnitus and to correlate the obtained results with pure tone thresholds and age. **Method:** hearing tests were performed in 44 subjects (hearing threshold up to 25 dB HL in the frequencies of 0.25 to 8 kHz). Two groups were considered for comparison: the Control Group with 23 subjects, 8 men and 15 women, aged between 22-40 (mean 29.7), and the Research Group with 18 tinnitus patients, 3 men and 15 women, aged between 21-45 (mean 31.3). All subjects underwent pure tone audiometry, speech tests, acoustic immittance measurements and the GIN test. For the statistical analysis, the significance level of 0.05 was adopted. **Results:** considering pure tone audiometry, the overall mean for hearing thresholds was significantly higher for the Research Group when compared to the Control Group ($p = 0.001$). The comparison between the groups for the performance in the GIN test indicated that the Control Group detected gaps with a shorter time interval than the Research Group ($p < 0.001$). There was no correlation between the age of the subjects and the level of the GIN test. **Conclusion:** the GIN test identified deficit in the hearing skill of temporal resolution in patients with tinnitus. In the studied age group (21 to 45 years) there was no correlation between age and the results obtained in the GIN test.

Key Words: Tinnitus; Auditory Perception; Hearing Tests; Hearing.

Resumo

Tema: o teste *Gaps-in-Noise* (GIN) avalia a habilidade auditiva de resolução temporal. Estudos têm mostrado o teste GIN como um instrumento de fácil aplicação, com boa sensibilidade e especificidade. **Objetivo:** comparar os resultados do teste GIN em ouvintes normais com e sem zumbido e fazer a correlação entre os resultados deste, os limiares tonais e idade. **Método:** foram avaliados 44 adultos (limiares tonais 25 dBNA nas frequências de 0,25 a 8 kHz), formando 2 grupos: Grupo Controle composto por 23 sujeitos, 8 homens e 15 mulheres, sem queixa de zumbido, idade entre 22 e 40 anos (média 29,7); Grupo Pesquisa formado por 18 indivíduos, 3 homens e 15 mulheres, com queixa de zumbido, idade entre 21 e 45 anos (média 31,3). Os sujeitos foram submetidos à audiometria tonal e vocal, imitancimetria e ao teste GIN. Para a análise estatística foi adotado nível de significância de 0.05. **Resultados:** na audiometria tonal, a média global dos limiares tonais foi mais elevada para o Grupo Pesquisa, comparado ao Grupo Controle ($p = 0,001$). A comparação do desempenho no teste GIN mostrou que o Grupo Controle detectou intervalos de silêncio em média com intervalo de tempo menor que o Grupo Pesquisa ($p < 0,001$). Não houve correlação entre a idade dos sujeitos e o limiar do GIN. **Conclusão:** o teste GIN identificou prejuízo na habilidade auditiva de resolução temporal nos indivíduos com zumbido. Na faixa etária pesquisada (entre 21 e 45 anos) não houve correlação entre a idade e os resultados do teste GIN.

Palavras-Chave: Zumbido; Percepção Auditiva; Testes Auditivos; Audição.

Introduction

The study of auditory processing assessment tools has been very useful in the clinical practice. The Gap-in Noise (GIN) test evaluates the ability of auditory temporal resolution of individuals. The temporal resolution is a sub-category of the temporal processing. It refers to the minimal time required to divide or solve acoustic events and it may be measured by the assessment of the detection of the minimum intervals of silence in a sound stimulus 1,2,3. Studies have presented the GIN test as a tool that is easy to apply and that presents good sensitivity and specificity 1,2.

Tinnitus is an otologic symptom and needs to be investigated due to its several etiological possibilities 4,5. The presence of tinnitus has been associated to a disorder in the neural activity of the auditory system. A cochlear disorder, even when undiagnosed by pure tone audiometry, may initiate a series of processes in the nervous system that may result in tinnitus 6,7,8. Oxenham and Bacon⁹ suggest that even small cochlear disorders may interfere in the cochlear amplification mechanisms, also affecting the auditory skill of temporal resolution.

Although there is no consensus regarding the influence of hearing loss upon temporal auditory tests, it is believed that the performance in auditory processing tests is better in individuals with preserved cochlear function. The investigation of the temporal processing in this population may help to understand the auditory perception in individuals with tinnitus and normal hearing thresholds.

This study aimed to compare results from the GIN test in two groups of normal hearing individuals (with and without tinnitus), and to correlate the results obtained to hearing thresholds and age of tested individuals.

Method

The study protocol was approved by the Ethics Committee for the Analysis of Research Projects of the Clinical Board of the Hospital das Clínicas - Faculdade de Medicina Universidade de São Paulo (HC-FMUSP) (protocol No. 428/06)

Participants

Hearing tests were performed in both ears of 44 adults with hearing thresholds \leq 25 dB at frequencies from 0,25 to 8 kHz. The sample was divided into two groups: Control Group, composed by 23 individuals (8 men and 15 women) from 22 to 40 years of age (mean age 29,7 years), without

tinnitus complaints; and Research Group, composed by 18 individuals (three men and 15 women) from 21 to 45 years of age (mean age 31,1 years), with a daily complaint of tinnitus perception. Of these 18 subjects, 12 presented bilateral tinnitus and six presented unilateral tinnitus (one in the left ear and five in the right ear).

Both ears of the individuals from Research Group were tested, even when the tinnitus was unilateral. Subjects being assisted at the Tinnitus Study Group of HC-FMUSP and at the Human Hearing Investigation Laboratory - FMUSP were invited to voluntarily participate in the research. .

Procedures

Subjects signed the informed consent term and then underwent immittance measures (Middle Ear Analyzer GSI 33 - Grason Stadler Version 2-ANSI 1987) and pure tone audiometry at frequencies from 0,25 to 8 kHz, with TDH 50P earphones (Audiometer GSI 61- Grason Stadler (ANSI S3,6-1989; ANSI S3,43-1992; IEC 645-1,1992; IEC 645 - 2, 1993; ISO 389; UL 544).

The test chosen to assess the temporal resolution was the Gap in Noise (GIN) test, proposed by Musiek et al.¹ and standardized for Brazilian-Portuguese by Samelli and Schochat². A compact disk with the recordings of the stimuli was played in a CD player coupled to the audiometer. Stimuli were monaurally presented at 50 dB SL above the speech recognition threshold (SRT). The task required was to identify the silence gaps, in milliseconds (ms), distributed along a white noise presentation. A series of 6s white noise stimuli was presented in each ear, in which silence gaps of different durations (2, 3, 4, 5, 6, 8, 10, 12, 15, 20 ms) were inserted. In each list, there were 6 silence gaps for each time duration in ms, totalizing 60. The number of silence gaps in each 6s of white noise varied from one, two, three or none. The shortest silence gap noticed by the subject in more than 50% of its presentation was considered a threshold. All the procedure was performed in both ears separately. Only lists 1 and 2 of the test were presented, one in each ear, alternately among the tested individuals.

The results obtained for each variable were analyzed through measurement of central tendency and inferential statistical analyses to compare groups using Mann-Whitney test and Spearman's correlation. The correlation coefficient was also calculated. The level of statistical significance was set at 0.05.

Results

The Mann-Whitney test showed no statistical difference in age distribution between Groups ($p = 0.469$).

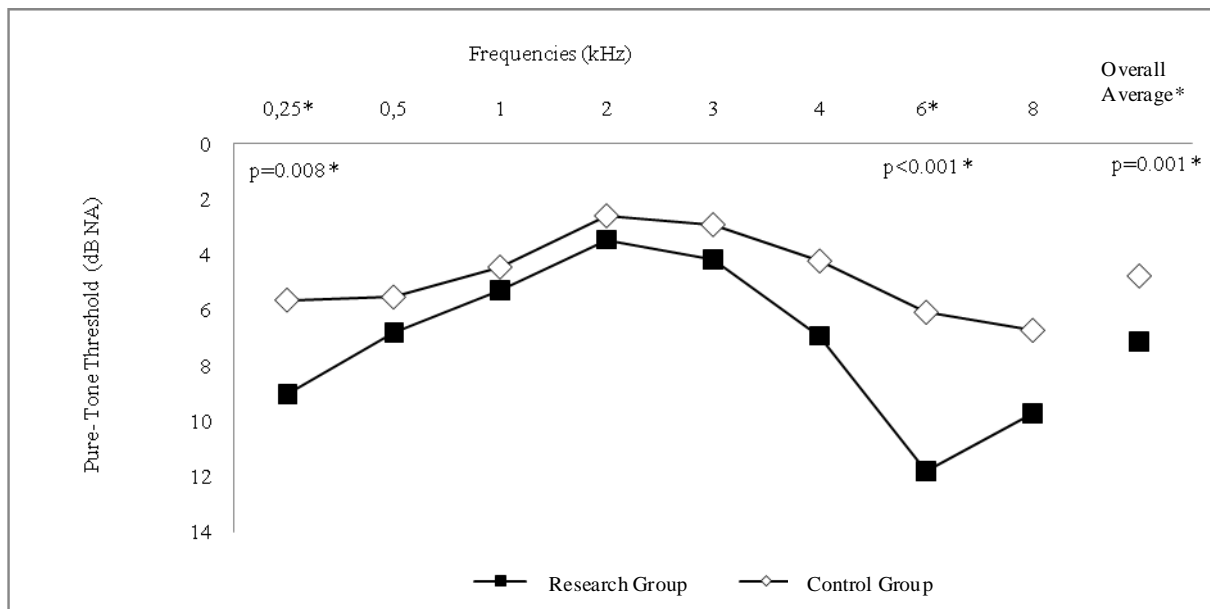
Figure 1 displays the comparison of the pure tone audiometry findings in both groups, evidencing that the overall mean of pure tone thresholds was higher in the Research Group when compared to the Control Group ($p < 0,05$).

The GIN test was analyzed according to the silence gaps detection threshold. The comparison of performances in the GIN test showed that the

Control Group detected, in average, silence gaps with shorter time of interval than the Research Group (Figure 2).

The overall hearing threshold (between 0,25 and 8 kHz) means of each individual were considered for the intra-group correlation analysis (Table 1). In both groups, there was no correlation between the age of subjects and the GIN threshold. There was a negative significant correlation between age and the average of hearing thresholds only for the research group, indicating that in this group the increase of age did not implicate in higher hearing thresholds at tested frequencies.

FIGURE 1. Comparison of average pure tone hearing thresholds at frequencies of 0.25 to 8 KHz and the overall average hearing thresholds between Groups.



Note: In the axis of Frequencies, the sign (*) identifies significant difference between the groups.

FIGURE 2. Between-groups comparison of GIN test results (mean ± SD).

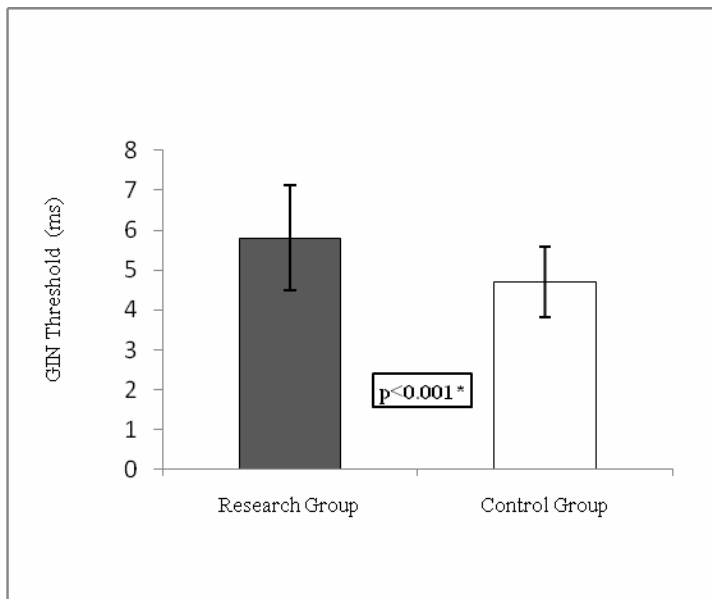


TABLE 1. Correlations between test results (GIN test, pure-tone thresholds) and age of individuals studied in each group.

		Control group		Research group	
		Age	Pure-Tone Threshold	Age	Pure-Tone Threshold
Pure-Tone Threshold	Corr	0.019		-0.428	
	p-value	0.898		0.009*	
GIN threshold	Corr	0.125	0.357	-0.207	0.384
	p-value	0.407	0.015*	0.226	0.021*

Note: Corr= Correlation

Discussion

Some considerations as regards to the population tested are noteworthy. In the sample of the current study there were more women with tinnitus than men. Savastano¹⁰ identified a higher incidence of men with tinnitus and normal hearing. In Brazil, prior research carried out by Sanchez et al.¹¹ identified more women than men with tinnitus and normal hearing seeking for ENT treatment. In the present study, performed in a specialized center, there were more women than men being assisted

and fulfilling the inclusion criteria at the moment of the research. Furthermore, only a few men volunteered to participate in the research. Samelli & Schochat², using the GIN test, did not find between genders differences regarding the GIN threshold and the percentage of correct responses in normal individuals therefore, not evidencing influence of gender in the results. It is noteworthy that Samelli & Schochat² used lists 1 and 2 of the GIN test - the same ones used in the present study.

The mean thresholds for identification of silence gaps found in this study were around 4,7 ms for the Control Group (Figure 2). In the literature, mean thresholds of 4,8 ms and 4,9 ms¹; 3,9 ms³; 4,19 ms²; 4,6 ms and 4,7 ms¹²; 4,45 ms and 5,61 ms¹³ had been found. The results obtained in the Control Group were approximated to those found in the literature, more specifically to studies of Musiek et al¹ and Rabelo¹².

Since there was no significant difference between the groups, age was not a determinant factor for the differences observed. According to Musiek et al.¹, the use of white noise as stimulus reduces the age interference. There was a negative correlation between age and hearing thresholds only for the Research Group. This suggests that, in an intra-group analysis, hearing thresholds did not increase with the increase in age. Nevertheless, the tinnitus complaints differentiated the hearing thresholds - which were increased when compared to the Control Group even being considered within normal limits. This suggests the onset of cochlear impairment in the Research Group. In a study with animals, Chen et al.¹⁴ investigated alterations in external hair cells and cochlear sensitivity. The authors observed loss of cochlear amplification only when there was a loss of 33% or more of external hair cells induced by the styrene. Considering such findings, it may be stated that although the Research Group of the current study presented normal hearing thresholds, individuals from this group may already present loss of external hair cells that is not being detected by the audiogram.

Moore and Oxenham¹⁵ reported that cochlear hearing losses cause more linear responses of the basilar membrane and this would result in reduced temporal resolution, among other disorders in sound processing. According to Glasberg et al.¹⁶, the difficulty in the temporal resolution task may be explained by the fact that the cochlear damage would result in a loss of cochlear compression, causing the auditory system to confuse the fluctuation levels inherent to the noise and, therefore, making the perception of silence gaps difficult. Furthermore, according to Glasberg et al.¹⁶, the most affected temporal processing of sound information abilities would be the temporal integration and the temporal resolution for fluctuating spectrum sounds such as narrow band noise. Despite the white noise having a less fluctuant spectrum than the narrow band noise, the results presented showed that there was some difficulty of temporal resolution in the group with tinnitus. The pure tone audiometry results previously

presented suggest the onset of cochlear impairment in the group with tinnitus.

Studies^{1,12} have shown that the GIN test is a very sensitive test to confirm lesions in the central auditory system. The difference found in the performance of the GIN test between patients with and without tinnitus evidence a dysfunction in the central auditory system in patients with tinnitus. Studies^{8,17,18} have also shown the relation between disorders along the central auditory pathway and tinnitus perception. The neural correlates of tinnitus described refer to disorders in different structures of the auditory pathway⁷. Physiologically, the detection of silence gaps in noise requires a precise processing of the temporal structure of the sound stimulus^{1,19}, being an integral system necessary so that the transmission of sound information through the auditory pathway may effectively occur. The investigation of auditory processing in patients with tinnitus may contribute in the development of therapeutic strategies to be added to the existing ones. The verification of altered specific tests may contribute with important data reflecting specific difficulties of these individuals.

The present study showed that the tested groups presented differences regarding the hearing thresholds and the performance in the GIN test. The difference observed between hearing thresholds may indicate the onset of cochlear impairment in patients with tinnitus. The study of Weisz²⁰ suggests that even in individuals with normal hearing thresholds, the tinnitus may be related to the lack of afferent peripheral auditory information, agreeing with the view that the cochlear damage initiates a series of alterations in the central auditory system, resulting in tinnitus^{4,7,17,21}.

It is expected that individuals with hearing loss have difficulty to obtain a good performance in tasks involving detection of silence gaps^{9,16,22,23}. Sanches et al.²⁴ showed the influence of hearing in frequencies above 8 kHz in the perception of silence gaps in the GIN test by individuals with tinnitus complaints. The present study reveals that the auditory deficit, even in individuals with normal pure tone thresholds (up to 25 dB HL), may already have had its onset as the Research Group presented higher hearing thresholds than the Control Group. The investigation of hearing thresholds in high frequencies (above 8 kHz) may be considered a complementary tool in the diagnosis of cochlear impairment in patients with tinnitus as differences between individuals with and without tinnitus have been reported in the literature^{25,26,27}.

The contribution of this study for patients with tinnitus is to link mild cochlear damages and the processing of sound information - which may be affected by alterations in the auditory pathway - suggesting the necessity of further studies involving the auditory processing in this population.

Conclusion

The GIN test identified auditory temporal resolution difficulties in patients with tinnitus. In the age group studied, no correlation was found between age and GIN test results.

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