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Original articles

Temporal resolution in elderly

Resolução temporal em idosos

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ABSTRACT

Purpose: detecting the sensitivity to evaluate the temporal resolution ability, by comparing Randon Gap Detection Test (RGDT) and Gaps- In-Noise (GIN) tests, in addition to suggesting reference values in these tests for elderly people.

Methods: 38 elderly people, 24 women and 14 men, aged between 60 and 82 years, with normal hearing or sensorineural to moderate hearing loss; with symmetry between the ears; Type A tympanogram, acoustic reflex, with auditory processing complaints. All patients underwent basic evaluations to characterize the peripheral hearing - RGDT and GIN.

Results: the sensitivity found for RGDT regarding the identification of the temporal resolution ability was 88.64% and 67.65% in GIN. The mean values for the gap detection thresholds in GIN test were around 8ms and for the RGDT test in 23,13ms.

Conclusion: RGDT test presented greater sensitivity for detecting the change in temporal resolution ability. The values of temporal resolution thresholds suggested as reference values for the elderly people, are 8ms for GIN and 23.13 ms for RGDT.

Keywords: Auditory Perception; Hearing Tests; Auditory Perceptual Disorders; Hearing; Comprehension

RESUMO

Objetivo: detectar a sensibilidade, para avaliar a habilidade de resolução temporal, comparando os testes Randon Gap Detection Test (RGDT) e Gaps- In-Noise (GIN) além de sugerir valores de referência nestes testes para idosos.

Métodos: participaram 38 idosos, 24 mulheres e 14 homens, com idades entre 60 e 82 anos, com audição normal ou perda auditiva neurossensorial até moderada; com simetria entre as orelhas; timpanograma tipo A, reflexos acústicos presentes, com queixa de processamento auditivo. Todos Foram submetidos a avaliação básica para caracterizar a audição periférica, RGDT e GIN.

Resultados: a sensibilidade encontrada para o teste RGDT na identificação da habilidade de resolução temporal foi de 88,64% e no GIN de 67,65%. Os valores médios para o limiar de detecção de gap no teste GIN encontraram-se em torno de 8ms e para o teste RGDT em 23,13ms.

Conclusão: o teste RGDT demonstrou maior sensibilidade para detecção da alteração da habilidade de resolução temporal. Os valores dos limiares de resolução temporal, sugeridos como valores de referência para idosos, são de 8ms para o GIN e 23,13 ms para o RGDT.

Descritores: Percepção Auditiva; Testes Auditivos; Transtornos da Percepção Auditiva; Audição; Compreensão

INTRODUCTION

The central auditory processing (AP) is responsible for many hearing-related phenomena in the nervous system (auditory cortex and pathways). The AP disorder is a hearing disorder in which there is impairment in the ability to analyze and/or interpret sound patterns[1].

An individual with AP disorders may have difficulty in sound localization, distinction of soft and loud sounds, understanding speech in background noise, having long talks, reading, spelling, writing, understanding double meaning, auditory memory and following auditory instructions[2].

The auditory system enables the processing of acoustic events whose function is to select the sounds of speech at the expense of competitive factors such as noise[3].

Hearing and speech understanding may be impaired in the aging process, since every structure of the organism changes slowly in this life stage[4]. Beyond these, it is possible to observe that cognitive functions alterations in elderly patients are characterized by slowness, suggesting a deficit in temporal processing transmission[5]. Many auditory information characteristics are in some way influenced by time[6].

The auditory temporal processing can be divided into four subcomponents or abilities: spatial or temporal sequencing, discrimination or temporal resolution, temporal summation or temporal integration and masking[6].

The same author defines temporal auditory processing as the perception of sound or sound changes within a limited and defined period of time. That is, it's the identification of small time intervals in which the individual can discriminate between two signals. The minimum interval recognized by the individual is called auditory temporal resolution threshold, being the temporal auditory acuity[6]. Currently, there are two temporal resolution tests available for clinical use: The Randon Gap Detection Test (RGDT) and Gaps-In-Noise (GIN).

The GIN test has been developed by Musiek (2004) to be used in clinical practice, in order to assess the gap detection threshold (silence interval). Inserted in the white noise stimuli, there are several gaps in different positions with variable durations[7].

The Randon Gap Detection Test - RGDT developed by Keith (2000) aims to evaluate the ability of temporal resolution by determining the shortest time interval that can be detected by individuals in milliseconds (ms) and obtained by their perception in a series of pairs of stimulus[8]. For test application, it's adopted pure tones at 500, 1000, 2000 and 4000 Hz, with a time interval between tones that ranges from zero to 40 ms in random order[7].

However, there is no recommendation in the specialized literature on which test has better applicability to the elderly, as well as reference values have not been described for the elderly and elderly with hearing loss. In this sense, there is the justification of this study, which aims to detect the sensitivity to assess the ability of temporal resolution, comparing the RGDT and GIN tests in the elderly and suggests reference values in the tests for this population.

METHODS

This is a prospective, quantitative and cross-sectional study. All assessments and examinations were carried out at the audiology clinic of a University Hospital, in a country town of the state Rio Grande do Sul.

The individuals who agreed to participate of this research were informed about the procedures, risks, benefits and confidentiality of the study and signed the Informed Consent Form (ICF). This study was approved by the Research Ethics Committee of the Federal University of Santa Maria in the Ethics Approval Certificate (EAC) number: 25933514.1.0000.5346.

For this sample were included elderly of both genders aged greater than or equal to 60 years; with normal hearing or moderate sensorineural hearing loss, according to Lloyd II and Kaplan criteria[9]; with symmetry between the ears (loss of the same extent or with small difference between the degrees up to 15 dB); tympanogram type A and contralateral acoustic reflexes; with apparent ability to participate in the proposed tests; who had no diseases in which the use of drugs for continuous treatment was necessary (which could interfere with alertness and performance on the day of testing, such as immunosuppressive drugs) and auditory processing complaints.

To meet the casuistry, the elderly were submitted to audiologic and temporal resolution anamnesis; visual inspection of the external auditory meatus; pure tone audiometry (PTA), speech audiometry; acoustic immittance measures and evaluation of the ability of temporal resolution through the GIN and RGDT tests.

In this study, 48 elderly agreed to participate but 2 were excluded because their hearing loss level was greater than moderate, 4 were excluded by conductive hearing loss and 4 by asymmetry between the ears;

the sample was composed of a total of 38 elderly, 24 female and 14 male, aged between 60 and 82 years.

The RGDT consists of sequences of paired pure tones at 500, 1000, 2000 and 4000 Hz. The intervals between tones range from zero to 40ms in random order, with increases from 2 to 10ms; and in expanded test the intervals between the tones range from 50 to 300ms in random order, with increases from 10 to 50ms. The test was performed in 40 dBSL binaural presented. The individuals were asked to verbally answer if they heard one or two tones. The training track and test tracks were applied, as well as the expanded form when needed. We verified the lowest interval from which the individual always identified two tones. The analysis was done by the average of the four test frequencies.

The GIN test is intended to evaluate the gap detection thresholds (silent interval). This test consists of a training track and 4 test tracks. Each test track presents various stimuli during 6 seconds of white noise, with a 5 seconds interval between stimuli. Inserted in the white noise stimuli, there are many gaps in different positions and varying lengths. The gaps may present 2, 3, 4, 5, 6, 8, 10, 12, 15 and 20 ms. In some stimuli, may not contain any gap or a single gap, as well as two or three gaps[7]. This was applied in 40dBSL in binaural mode because previous studies have shown that there is no difference between ears[10,11].

For the statistical analysis of this study, we used McNemar's test and Wilcoxon sign-ranked test for the comparison of the results of RGDT and GIN tests. For the sensitivity and specificity analysis of RGDT and GIN tests, we adopted the kappa coefficient of agreement. The significance level for the statistical tests was 5% ($P < 0.05$).

RESULTS

From August 2014 to July 2015, 48 elderly people who agreed to participate on the research were voluntary assisted. Were excluded 2 elderly due to hearing loss greater than moderate, 4 by conductive hearing loss and 4 by asymmetry between the ears.

Therefore, our sample consisted of 38 elderly, 24 female and 14 male, aged between 60 and 82 years. The description of the sample is presented in Table 1.

It was possible to observe in Table 2 that among the individuals evaluated, more than half had hearing thresholds within normal limits, followed by sensorineural hearing loss from mild to moderate degree.

Table 3 presents the distribution by percentage and frequency of individuals and their performance, classified as normal or abnormal, compared to existing benchmarks.

Table 4 shows the comparison of the values of temporal resolution thresholds between GIN and RGDT tests.

Both tests, GIN and RGDT, were analyzed for sensitivity, specificity and accuracy. The results obtained are shown in Table 5.

Table 1. Descriptive data of the sample in terms of gender and age in years

	N	Percentage %	Average	SD	Min	Med	Max
Male	24	63.16					
Female	14	36.84					
Overall	38						
Age			67.50	6,18	60,00	66,00	82,00

Legend: N= total sample number; Min= minimum; Med= median; Max= maximum; SD= standard deviation.
Descriptive analysis of the variables.

Table 2. Descriptive data of the sample concerning audiometric configuration by ear

	Ear	N	FREQ.	PERC. %	Average	SD	Min	Med	Max
TA	RE	38	-	-	27.97	13.59	8.00	25.00	55.00
TA	LE	38	-	-	26.99	18.83	10.00	23.34	55.00
NH	RE	-	21	55.26	-	-	-	-	-
MIHL	RE	-	9	23.68	-	-	-	-	-
MOHL	RE	-	8	21.05	-	-	-	-	-
NH	LE	-	21	55.26	-	-	-	-	-
MIHL	LE	-	11	28.95	-	-	-	-	-
MOHL	LE	-	6	15.79	-	-	-	-	-

Legend: TM=triton average; NH= normal hearing; MIHL=mild hearing loss; MOHL=moderate hearing loss; RE=right ear; RE=left ear; N= total sample number; FREQ=frequency; PERC=percentage; SD=standard deviation; Min= minimum; Med= median; Max= maximum.
Descriptive analysis of the variables.

Table 3. Descriptive values to Randon Gap Detection Test and Gaps-In-Noise in terms of normality (in accordance with the existing reference criteria)

	Frequence (n)	Percentage %
Normal GIN	4	10.53
Abnormal GIN	34	89.47
Normal RGDT	12	31.58
Abnormal RGDT	26	68.42

Legend : RGDT=Randon Gap Detection Test ; GIN=Gaps-In-Noise.
Normality criteria for GIN: 4ms / RGDT: 10ms.
Wilcoxon Signed-Rank Test.

Table 4. Values of thresholds found for Random Gap Detection Test and Gaps-In-Noise in the elderly

	N	Mean (ms)	SD	Min	Q1	Med	Q3	Max	p-value
RGDT	38	31.58	40.04	3.50	7.50	23.13	33.75	175.00	p> 0.001
GIN	38	7.70	3.37	1.00	6.00	8.00	10.00	15.00	
Dif RGDT GIN	38	23.88	39.56	-6.00	2.00	13.50	25.50	165.00	

Legend: N= total sample number; SD=standard deviation; Min= minimum; Med= median; Max= maximum; RGDT=Randon Gap Detection Test; GIN=Gaps-In-Noise.
statistically significant values (p≤0,05) - Wilcoxon Signed-Rank Test.

Table 5. Sensitivity, specificity and accuracy values for Random Gap Detection Test and Gaps-In-Noise, using both as gold standard

	RGDT as gold standard %	GIN as gold standard %
Specificity	8,88	25,00
Sensitivity	88,64	67,65
Accuracy	63,16	63,16

Legend: RGDT=Randon Gap Detection Test; GIN=Gaps-In-Noise.
Kappa coefficient

DISCUSSION

By analyzing the sample of this study (Table 1), it is possible to observe there is a predominance of females (63.16%), with average age of 67.5 years; 55% of the sample presented normal hearing in both ears, and symmetrical pure tone average on mild to moderate hearing loss of sensorineural type. Other research with elderly and temporal resolution showed similar mean age [12-16].

Concerning the audiometric configuration analyzed by ear, observed in Table 2, the number of MIHL and MOHL is different, but the symmetry between the ears was preserved because a small difference in pure tone average changed the degree of hearing loss. It was ensured that all thresholds did not exceed moderate values.

This data is supported by another study [12] with elderly with hearing loss and temporal resolution, which investigated the effect of temporal resolution ability in the temporal ordering in a population of ten (10) elderly between 60 and 80 years, with and without hearing loss from mild to moderate, and which concluded that the ability of temporal resolution does not interfere in the temporal ordering ability in this population. In another research [13], the authors compared the performance of temporal auditory processing among elderly between 60 and 81 years with and without hearing loss up to moderately severe and observed that the hearing loss did not affect the results for the RGDT test.

Considering these information, in this study we did not perform any division concerning audiometric configuration, due to the evidence that it does not interfere with temporal resolution thresholds in both tests. Still, other studies have found similar results [16,17].

Table 3 shows that the number of changed elderly in GIN test is higher (89.47%) than the value found for RGDT (68.42%). This fact is explained due to the reference value for normality in GIN test, 4ms, according Samelli and Schochat (2008) [18], while for RGDT the value is 10 ms, according to Musiek et al. (2004) [7]. Based on this reference value for ages between 18 and 31 years, the number of alteration for GIN is higher because the threshold is lower (4ms).

Further, we can observe in Table 4 that this difference is statistically significant with 3.5 ms as minimum value for RGDT and 1ms for GIN test, while 175 ms as maximum value for RGDT and 15ms for GIN test, with very distinct average values, being 31.58 for RGDT and 7.70 for GIN.

These data differs from another study [15] which has been conducted by application of RGDT in 63 elderly, aged between 60 and 80 years, with 53 females and 10 males, in which average values were found for women (n=53), with minimum values of 91.36 ms and maximum of 118.26 ms for temporal resolution thresholds.

Other authors[16] compared 48 young women with mean age of 23.8 years and 24 elderly women with mean age of 66.8 years in their performances for RGDT. The authors observed, in the older group, that 20 of 24 women did not identify the range of up to 40 ms in one or more frequencies, but the test was not applied expanded to identification of average values of thresholds temporal resolution of 40 ms.

The authors identified, in the elderly group, that 20 of 24 women did not identify the range of up to 40 ms in one or more frequencies, but the expanded test was not applied for identification of average values of thresholds temporal resolution of 40 ms.

Despite having different mean ages, we considered important to present the findings for the GIN test, in the following studies, because there are just a few studies applying it.

This study resembles to another research[17] in which they assessed 57 individuals, aged between 20 to 59 years, with sensorineural hearing loss of mild and moderate levels through the Gaps in Noise (GIN) test. This research verified that there was no statistical difference for the threshold values in GIN test between the groups, concluding that the ability of temporal resolution is not influenced in these degrees of hearing loss for GIN test. Thus, the average gap detection threshold of the sample was 8.2 ms in both ears.

In a study[19] conducted in normal hearing individuals in order to evaluate the ability of temporal resolution using GIN and RGDT tests, the results corroborate the same in relation to the GIN test, in which were found average values of thresholds time resolution of 6.7 ms, however those are different from the values found for the RGDT, which presented 10,1 ms. These values were found for the group aged between 51 and 60 years.

By comparing it to the present study, we identified a similarity in the temporal resolution of threshold values for the GIN test, even in different age groups and audiometric configurations. This fact reinforces the aforementioned, that the temporal resolution thresholds for this test do not suffer interference from hearing loss in results and corroborate a recent study[19,] which did not find threshold increase for the GIN test from 40 to 60 years. As for the RGDT, there is no significant difference in the values of the thresholds temporal resolution, mainly because most studies we found are focused on younger age groups, since many research [13,16,19] confirmed the marked values increase in temporal resolution thresholds with increasing age for RGDT. According Table 5, RGDT showed greater sensitivity in identifying the temporal resolution ability in elderly with auditory processing complaints, compared to the GIN test.

In the central hypothesis of this study, changes in the ability of temporal resolution was expected for this elderly population with auditory processing complaints, since it is known that the temporal resolution threshold increases with age, leading to higher auditory processing complaints. This statement can also be found in other studies [13,16,19]. Besides, this study expected to enable new reference values for elderly patients with normal or mild/moderate sensorineural hearing loss, and we achieved our goal, although the sample was not very large, which is the major limitation of the study, since the collection occurred during twelve consecutive months. We hope this research can be valid for other studies with this population and for the clinic, considering the importance of the temporal resolution ability. Therefore, we considered RGDT the most appropriate test to detect changes in temporal resolution ability for the assessed elderly population, since many elderly people who had lower thresholds in the GIN test showed higher thresholds in RGDT. This fact could result in failure to detect the change in the temporal resolution ability when evaluated with the GIN test.

CONCLUSION

The RGDT test demonstrated higher sensitivity for detecting changes in temporal resolution ability of elderly with auditory processing complaints. The values of temporal resolution thresholds, suggested as benchmarks, are 8ms for GIN test and 23.13 ms for RGDT test for both genders.

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