International Tinnitus Journal, Vol. 13, No. 1, 11–14 (2007)

High-Frequency Hearing Threshold in Adult Women with Multiple Sclerosis

Bianca S. Zeigelboim,[1] Walter O. Arruda,[2] Maria Cecília M. Iório,[3] Ari L. Jurkiewicz,[1] Jackeline Martins-Bassetto,[1] Karlin F. Klagenberg,[1] and Pedro L. Mangabeira-Albernaz[4]

[1] *Department of Audiology, Universidade Tuiuti do Paraná, Curitiba;* [2] *Instituto de Neurologia de Curitiba, Curitiba; and Departments of* [3] *Audiology and* [4] *Otorhinolaryngology, Universidade Federal de São Paulo, São Paulo, Brazil*

Abstract: Our objective was to determine the high-frequency hearing thresholds of women with multiple sclerosis (MS) and to investigate the presence of side dominance for high-frequency perception. We submitted 19 affected and 106 nonaffected women (controls) to high-frequency audiometry and classified them in subgroups according to their age (30–40, 40–50, and 50–60 years). We analyzed data through selected statistical tests. We could detect no consistent effect of side dominance and observed a general increase in the hearing sensitivity for high frequencies in MS patients. We concluded that high-frequency sounds seemed to be detected more easily by MS patients than by controls.

Key Words: auditory threshold; hearing loss; hearing tests; high frequency; multiple sclerosis

Hearing alterations in multiple sclerosis (MS) are generally described in the literature as gradual threshold decreases in high frequencies [1–4], often observed with alterations of the acoustic reflex [5]. Tonal audiometry evaluates frequencies from 0.25 to 8 kHz. However, in some specific situations, descendant curves may indicate a diminished high-frequency auditory perception. High-frequency evaluation may search hearing thresholds within the range of 9–18 kHz, depending on the equipment used. This evaluation contributes to early detection of hearing loss attributable to lesions located in the base of the cochlear duct and may indicate alterations even before the characteristic effects appear in the conventional frequency range. It is also important to monitor hearing function during treatment with ototoxic drugs, because the use of such drugs may damage the cochlea, initially affecting the highest frequencies [6].

As MS affects women more than twice as often as men (approximately 70% female and 30% male) [7], the aim of this study was to compare the high-frequency hearing thresholds of female MS patients with those of members of a control group. The literature lacks data on high-frequency hearing thresholds for the normal population. In addition, we performed an investigation into the presence of a side-dominance effect for high-frequency perception.

Reprint requests: Bianca Simone Zeigelboim, SLP, PhD, Rua: Gutemberg No. 90, Floor 9, Batel, Curitiba/PR 80420-030, Brazil. Phone: (+55 41) 3331-7807; E-mail: bianca.zeigelboim@utp.br

METHOD

This project was submitted to and fully approved by the local ethics committee,* and the volunteers read and signed an informed consent to become enrolled in this research. The study group consisted of 19 women, ranging in age from 30 to 60 years, who had diagnosed relapsing-remitting MS according to criteria from Poser et al. [8] and McDonald et al. [9].

We set up three subgroups according to age ranges: 30–40 years (n = 9), 40–50 years (n = 6), and 50–60 years (n = 4). Our control group consisted of 106 women aged 30–40 years (n = 81), 40–50 years (n = 18), and 50–60 years (n = 7).

* Universidade Tuiuti do Paraná, protocol number 084/2005

In all subjects, we performed neurological and auditory evaluations. The latter comprised pure-tone audiometry, speech perception thresholds, speech discrimination scores, and immittance tests. The exclusion criteria were presence of any otological conditions or otological history (or both) and altered results for the audiometry test [10] and immittance test [11]. We performed a high-frequency threshold search using the AC40 high-frequency audiometer by Interacoustics (Assens, Denmark) and digital earphones HV/PRO by Koss (Milwaukee, WI, USA). The evaluated frequencies ranged from 9 to 16 kHz as follows: 9, 10, 11.2, 12.5, 14, and 16 kHz.

We used the Wilcoxon test to compare left and right high-frequency hearing thresholds of the MS and control groups, according to age range, with a significance level of 5%. We used the Mann-Whitney test to compare our study group with our control group, by ear and by age range, with a significance level of 5%.

RESULTS

The analyses for the effect of side dominance considered the number of valid cases (i.e., the number of individuals who could respond to the tested stimulus in at least one ear). Results were inconsistent for both study and control groups (Table 1): Those in the control group were positive at 11.2 kHz (30–40 years) and 12.5 kHz (40–50 years), whereas those in the MS group were positive at 9 kHz (30–40 years), 14 kHz (40–50 years), and 16 kHz (40–50 years).

Table 1. Valid Cases According to Age Range and Presence of Effect of Side Dominance for High-Frequency Auditory Perception

Frequency (kHz)	Valid Cases of MS (per age range, yr)			Valid Cases of MS Among Controls (per age range, yr)		
	30–40	40–50	50–60	30–40	40–50	50–60
9	9*	5	3	81	18	7
10	9	5	3	81	18	7
11.2	9	5	3	81*	18	7
12.5	9	5	3†	78	17*	7*
14	9	5*	3†	77	17	4†
16	9	5*	3†	73	15	1†

*$p \leq .05$ (Wilcoxon test).
†Test not performed owing to lack of data.

Table 2 shows the high-frequency hearing threshold averages and standard deviations. MS patients from 30 to 50 years old presented a significantly lower average at 9 kHz (left ear) and at 16 kHz (both ears) in comparison to the controls; beyond 50 years of age, subjects with MS presented a lower average threshold at 14 kHz (left ear).

Table 2. Valid Cases and Average and Standard Deviation of Left- and Right-Ear Hearing Thresholds in Multiple Sclerosis and Control Groups According to Age Range

Frequency (kHz)		Age 30–40 Yr				Age 40–50 Yr				Age 50–60 Yr			
		Right Ear		Left Ear		Right Ear		Left Ear		Right Ear		Left Ear	
		MS	CTRL	MS	CTRL	MS	CTRL	MS	CTRL	MS	CTRL	MS	CTRL
9	N	9	81	9	81	6	18	6	18	4	7	4	7
	AVG (dB)	29.4	34.6	17.8	33.7*	37	45	31	46.1*	60	64.3	55	57.9
	±SD	7.68	13.47	7.95	12.32	14.4	15.62	11.4	11.58	18.03	28.05	21.79	24.98
10	N	9	81	9	81	6	18	6	18	4	7	4	7
	AVG (dB)	32.8	37.2	36.1	35.9	40	47.2	48.4	44.2	63.3	67.1	68.3	59.3
	±SD	10.64	15.91	9.28	14.62	15.41	16.11	12.76	13.42	12.58	23.25	28.87	28.78
11.2	N	9	81	9	81	6	18	6	18	4	7	4	7
	AVG (dB)	40.6	39.9	35	37.1	43	52.8	56	47.8	80	78.6	71.7	65.7
	±SD	13.79	18.02	10.31	17.94	12.04	19.57	14.75	20.24	10	19.3	32.15	27.15
12.5	N	9	78	9	80	6	17	6	18	4	7	4	7
	AVG (dB)	43.3	41.1	40.6	41.9	51	57.1	62	50.8	85	94.3	86.7	81.4
	±SD	14.58	17.57	11.58	20.65	21.62	21.07	14.4	23.84	5	13.36	15.28	17.49
14	N	9	78	9	77	6	17	6	17	4	5	4	6
	AVG (dB)	43.3	57.3	45.6	55.7	68	82.6	85	76.5	86.7	102*	91.7	98.3
	±SD	19.69	22.14	16.67	22.37	18.91	21.3	14.58	21.27	2.89	5.7	2.89	8.16
16	N	9	75	9	74	6	15	6	16	4	2	4	2
	AVG (dB)	65.6	84.1*	65	83.4*	86	105.7*	92	103.8*	90	102.5	90	105
	±SD	16.29	19.97	18.2	20.26	6.52	6.78	6.71	7.85	0	3.54	0	7.07

*$p \leq .05$ (Mann-Whitney test).
AVG = average (dB); CTRL = control group; MS = multiple sclerosis group; N = number of valid cases; SD = standard deviation.

In the MS group, the number of valid cases was constant as the tested frequency increased, meaning that all subjects were able to respond for every searched frequency. Conversely, in the control group, the number of valid cases consistently dropped with the progressive increase of the tested frequency (see Table 2). We observed a consistent increase in the average hearing threshold along with the age-range progression for both MS and control groups in every tested frequency.

DISCUSSION

Information presented in the literature on hearing loss (incidence, types, and degrees) in MS remains controversial, probably owing to the diffuse characteristics and wide variability of clinical manifestations observed in this disease [4,5]. The literature contains no information on the presence of an effect of side dominance for high-frequency hearing thresholds either in the normal-hearing population or in MS patients. Our research was inconclusive in this respect, and further investigation with larger samples may achieve more reliable results.

Several authors have affirmed that deep auditory losses are not likely to occur as a typical symptom of MS and that, if present, auditory alterations tend to be mild [5,12,13]. Isolated neurosensory auditory losses may occur as a rare initial manifestation of MS [4,5], present in approximately 1% of affected patients [4]. Colletti [14] mentioned that 4% of evaluated patients presented some measurable change for low and medium frequencies. Conversely, several authors reported audiometric profiles with auditory losses in high frequencies and normal tonal sensitivity for low and medium frequencies in MS patients [1,2,15,16]. In our study, we found no evidence of hearing loss in MS patients. Nevertheless, regardless of the age range, affected patients were able to respond to every tested frequency, whereas the number of controls able to respond to stimuli has consistently dropped with the increase of the tested frequency. This finding suggests that high-frequency hearing sensitivity may be generally increased in MS patients.

We observed a decline in the high-frequency sensitivity with a concomitant increase of the frequency of stimulus and the age range in both study groups (see Table 2). This finding is in general agreement with previously reported studies of normal-hearing subjects [6,17,18]. In spite of numerous investigations, the causes of hearing loss in MS are still unclear. What is known, however, is that hearing deficits in some frequencies are a potential consequence of interruptions of the auditory paths, which may be caused by demyelinization.

CONCLUSION

We cannot state unequivocally, on the basis of our study or information in the literature, that the increased perception of high-frequency sounds is directly related to MS. However, our results suggest that high-frequency sounds seemed to be more easily detected by MS patients in comparison to controls. Further research is needed to achieve reliable conclusions. We could detect no consistent effect of side dominance either in MS patients or in controls, though we could observe a general increase in the high-frequency hearing sensitivity in subjects with MS.

ACKNOWLEDGMENTS

Support for this study was provided by the Brazilian National Council for Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico–CNPq).

REFERENCES

1. Von Leden H, Horton BT. The auditory nerve in multiple sclerosis. *Arch Otolaryngol* 48:51–57, 1948.
2. Bentzen O, Jelnes K, Thygesen P. Acoustic and vestibular function in multiple sclerosis. *Acta Psychiatr Neurol Scand* 26:265–295, 1951.
3. Jerger JF, Oliver TA, Chmiel RA, Rivera VM. Patterns of auditory abnormality in multiple sclerosis. *Audiology* 25: 193–206, 1986.
4. Özünlü A, Mus N, Gülhan M. Multiple sclerosis. A cause of sudden hearing loss. *Audiology* 37:52–58, 1998.
5. Franklin DJ, Coker NJ, Jenkins HA. Sudden sensorineural hearing loss as a presentation of multiple sclerosis. *Arch Otolaryngol Head Neck Surg* 115:41–45, 1989.
6. Zeigelboim BS, Mangabeira-Albernaz PL, Fukuda Y. High frequency audiometry and chronic renal failure. *Acta Otolaryngol* 121:245–248, 2001.
7. Grènman R. Involvement of the audiovestibular system in multiple sclerosis: Otoneurologic and audiologic study. *Acta Otolaryngol Suppl (Stockh)* 420:1–95, 1985.
8. Poser CM, Paty DW, Scheinberg L, et al. New diagnostic criteria for multiple sclerosis: Guidelines for research protocols. *Ann Neurol* 13:227–231, 1983.
9. McDonald WI, Compston A, Edan G, et al. Recommended diagnostic criteria for multiple sclerosis: Guidelines from the International Panel on the Diagnosis of Multiple Sclerosis. *Ann Neurol* 50:121–127, 2001.
10. Mangabeira-Albernaz PL. Otoneurological aspects of senility [in Portuguese]. *Acta Awho* 1(3):93–95, 1982.
11. Jerger J. Clinical experience with impedance audiometry. *Arch Otolaryngol* 92:311–324, 1970.
12. Noffsinger D, Olsen WO, et al. Auditory and vestibular

aberrations in multiple sclerosis. *Acta Otolaryngol* 303:1–63, 1972.

13. Daugherty WT, Lederman RJ, Nodar RH, Conomy JP. Hearing loss in multiple sclerosis. *Arch Neurol* 40:33–35, 1983.

14. Colletti V. Stapedius reflex abnormalities in multiple sclerosis. *Audiology* 14:63–71, 1975.

15. Citron L, Dix MR, Hallpike CS, Hood JD. A recent clinico-pathological study of cochlear nerve degeneration resulting from tumor pressure and disseminated sclerosis with particular reference to the finding of normal threshold sensitivity for pure tones. *Acta Otolaryngol* 56:330–337, 1963.

16. Luxon LM. Hearing loss in brainstem disorders. *J Neurol Neurosurg Psychiatr* 43:510–515, 1980.

17. Dreschler WA, Hulst RJAM, Tange RA, Urbanus NAM. The role of high-frequency audiometry in early detection of ototoxicity. *Audiology* 24:387–395, 1985.

18. Stelmachowicz PG, Beauchaine KA, Kalberer A, et al. High frequency audiometry: Test reliability and procedural considerations. *J Acoust Soc Am* 85:879–887, 1989.