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Research Article

Hearing Profile of Multiple Sclerosis Patients in Jordan: A Case-Control Study

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Abstract

Objective: To determine and evaluate the difference in audiometric hearing status between individuals with and without Multiple Sclerosis (MS).

Background: MS is a chronic degenerative disease characterized by multifocal demyelination of the Central Nervous System (CNS), and thus resulting in many neurologic findings that are disseminated in place and time. Although MS affects the CNS as a whole, MS patients rarely report any complaints about their hearing status. The estimates regarding the prevalence of pure tone hearing abnormality in this patient population vary greatly. Several studies reported conflicting results about the chronic effect of MS on hearing thresholds and while some studies concluded no significant association, other studies reported a significant association. The frequencies at which MS patients had hearing deficits were various in these studies.

Methods: Using Pure Tone Audiometry (PTA), pure tone air-conduction thresholds were recorded at 0.25, 0.5, 1, 2, 4, and 8 kHz in 60 MS patients and 89 healthy controls. According to the means of the thresholds across these frequencies, the ears of each MS patient were classified to Better Hearing Ear (BE) or Worse Hearing Ear (WE). Mean thresholds of BEs and WEs were then compared to the mean thresholds of both ears of healthy controls.

Results: Hearing thresholds of WEs of MS patients were significantly higher than controls at all tested frequencies (all Ps <0.01). Moreover, hearing thresholds of BEs of MS patients were significantly higher than controls at 0.5, 4, and 8 kHz (all Ps < 0.05). No correlation was found between auditory thresholds and duration of the disease.

Conclusions: The study supports that MS does influence auditory thresholds unilaterally at low-mid frequencies and asymmetrically and bilateral at mid-high frequencies.

Keywords: Multiple sclerosis; Hearing; Hearing loss; Pure tone thresholds; Audiometry

Introduction

Multiple Sclerosis (MS) is a chronic degenerative disease characterized by multifocal demyelination of the Central Nervous System (CNS), and thus resulting in many neurologic findings that are disseminated in place and time. Interestingly, despite the fact that MS affects the CNS as a whole, it can present with many visual, sensory, motor, autonomic and cognitive symptoms with some symptoms being more common and consistent with MS than others, depending on the site of the lesion [1]. For instance, auditory system is one of the sensory neurologic systems that can be affected by MS. However, there is no solid consensus in the literature about the prevalence, pattern or types of auditory deficits that are caused by MS. This may be attributed to the nature of the disease itself or the variety of tests used to assess hearing. Despite that, it is generally agreed that when such deficits do occur, they are mild and usually go unnoticed [2].

Acute effect of MS on hearing can be attributed to lesions that involve the eighth cranial nerve, the cochlear nucleus and the pontine trapezoid body of the brainstem. However, the mechanism for its chronic effect on hearing is still unclear [3].

In order to evaluate the chronic effect of MS on hearing, several studies have used Pure Tone Audiometry (PTA) to compare hearing thresholds between MS patients and controls. While some studies reported no significant influence of MS on pure-tone hearing thresholds [3-5], others reported that hearing loss is present more in MS patients compared to controls at variable frequencies [6-10]; suggesting that there is no unique pure-tone audiometric configuration specifically associated with the disease.

Despite of the discrepancies between the studies, all aforementioned studies compared the means of hearing thresholds for right ears, left ears, or both ears between MS and control groups without considering better and worse hearing ears in MS patients. Therefore, in order to evaluate the effect of MS on the auditory system, we compared hearing thresholds of better and worse hearing ears of MS patients and controls using PTA.

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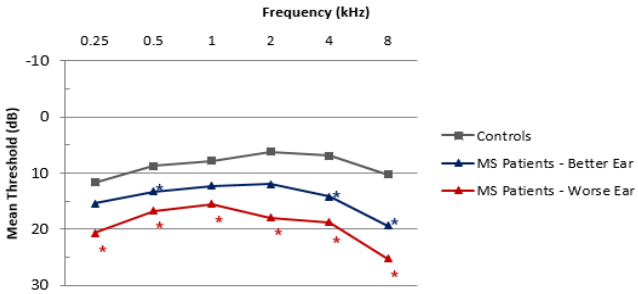

Figure 1: Mean pure tone thresholds of MS patients and controls.
* P < 0.05 (compared with controls).

Table 1: Characteristics of study participants.

	MS patients (N=60)	Controls (N=89)
Age (years)	37.43±10.54	31.52±9.95
Gender		
Male	26 (43.3)	36 (40.4)
Female	34 (56.7)	53 (59.6)
Disease duration, yr	9.05±6	
MS presenting complaint		
Visual disturbance	25 (41.7)	
Muscle weakness	25 (41.7)	
Sensory abnormality	7 (11.7)	
Dizziness	2 (3.3)	
Otolaryngology complaint		
Hearing difficulty	21 (35)	
Tinnitus	26 (43.3)	
Vertigo	9 (15)	
Family history of hearing problems	15 (25)	
Noise exposure	16 (26.7)	

Values are expressed as mean ± SD and N (%).

Methods

Study population

Study protocol was approved by the Research Ethics Committee at Jordan University Hospital. MS patients with definite MS according to the revised McDonald Criteria [11] at the Health Insurance Directorate of the Ministry of Health, Jordan University Hospital, and Multiple Sclerosis Society of Jordan, who agreed to provide their contact information for future research projects [12], were invited to participate in this study.

Patients were then interviewed and assessed for eligibility. MS patients older than 18 years old, with no other disorders affecting hearing, no family history of hearing loss and with normal otoscopic examination and tympanometric measurements were included.

Controls were recruited from the local community. Controls were included if they were older than 18 years old, had no co-morbidity or health problem, had no hearing complaints or difficulty, had no noise exposure, and had normal otoscopic examination and tympanometric measurements.

Participants from both groups were asked to fill an informed consent and provide demographic information. After that they underwent PTA testing at the otolaryngology department at Jordan University Hospital.

Table 2: Degrees of hearing loss.

	MS patients		Controls
	Better Ear	Worse Ear	Both ears
Normal	43 (71.7)	38 (63.3)	80 (89.9)
Slight Hearing Loss	9 (15)	11 (18.3)	9 (10.1)
Mild Hearing Loss	6 (10)	7 (11.7)	0
Moderate Hearing Loss	1 (1.7)	1 (1.7)	0
Moderately Severe Hearing Loss	0	1 (1.7)	0
Severe Hearing Loss	1 (1.7)	1 (1.7)	0
Profound Hearing Loss	0	1 (1.7)	0

Values are expressed as N (%).

Hearing measurement

Hearing thresholds in Decibels (dB) were measured at 0.25, 0.5, 1, 2, 4, and 8 kHz for both ears of MS patients and controls using PTA. The measurement was conducted using standard procedures recommended by the American Speech-Language-Hearing Association [13].

According to the means of the thresholds across all measured frequencies, each ear of every MS patient was classified into Better Ear (BE) or Worse Ear (WE). Mean thresholds of BEs and WEs were then compared to the mean thresholds of both ears of healthy controls.

Degree of Hearing Loss (HL) according to the mean hearing thresholds (dB) at (0.5, 1, 2, and 4 kHz) for each ear was classified into: Normal hearing (-10–15); Slight HL (16–25); Mild HL (26–40); Moderate HL (41–55); Moderately severe HL(56–70); Severe HL(71–90); or Profound (HL) (>91) [14].

Statistical analysis

Data was entered into and analyzed using the Statistical Package for Social Sciences (SPSS), version 20. Categorical variables were described as frequencies and percentages and compared using Pearson's X^2 -test. For analysis of continuous variables, all data were analyzed initially using the Kolmogorov-Smirnov test, histograms and Q-Q plots to assess for normality. Continuous variables were described as mean ± Standard Deviation (SD) and compared using t test and Mann-Whitney U test. Correlations between variables were assessed using Spearman's rank correlation test. P <0.05 was assigned as the alpha.

Results

Participant characteristics

A total of 60 MS patients and 89 healthy controls participated in the study. The study participants' demographic characteristics are presented in Table 1. Both groups had similar gender composition (P=0.726), but MS patients were older than controls (P=0.000).

Degree of hearing impairment

Table 2 shows the degree of hearing impairment in each ear of MS patients and both ears of controls. Hearing impairment of any degree was found more in BEs (17 (28.3%)) and WEs of MS patients (22 (36.7%)) than controls (9 (10.1%) with P=0.004, P=0.000,

Table 3: Mean thresholds (dB) of participants in different age groups.

	Age (20-39)					Age (40-45)				
	Controls (N=69)					Controls (N=20)				
	Both Ears	Better Ear		Worse Ear		Both Ears	Better Ear		Worse Ear	
Frequency (kHz)	Mean ± SD (dB)	Mean ± SD (dB)	P values compared with controls	Mean ± SD (dB)	P values compared with controls	Mean±SD (dB)	Mean±SD (dB)	P values compared with controls	Mean±SD (dB)	P values compared with controls
0.25	10.8±.1	14.8±13.4	0.252	20.4±24.1	0.132	15 ± 7.1	16.3±12.8	0.634	21±15.2	0.348
0.5	7.6 ±6	12.1±12.8	0.103	16.5±20.4	0.025*	12.8±6.2	15±11.8	0.877	17.1±13.5	0.466
1	6.6 ±5.9	10.6±13.6	0.396	15.3±20.8	0.013*	12.1±5	14.8±10.9	0.618	15.9±12.5	0.467
2	4.2 ± 6.5	11.1±16.9	0.046*	19.1±28.3	0.000***	13±6.8	13.3±14	0.324	16.3 ± 14	0.593
4	4.5±10.7	12.8±16.6	0.004**	16.7±22.1	0.000***	15.1±7.5	16.3±17	0.499	21.9±17.5	0.418
8	7.7 ± 9.9	18.8±23.1	0.005**	23±26.2	0.000***	19±12.5	20.4±17.2	0.831	28.6±20.9	0.178

* P < 0.05. ** P < 0.01. *** P < 0.001.

respectively. However, most hearing impairment severities were only slight and mild hearing loss.

Hearing profile

Figure 1 shows mean thresholds (dB) of PTA testing for MS patients and controls. Mean thresholds of better ears of MS patients were 15.4, 13.3, 12.3, 12, 14.2, and 19.4 dB at 0.25, 0.5, 1, 2, 4, and 8 kHz, respectively. Mean thresholds of worse ears of MS patients were 20.7, 16.8, 15.6, 18, 18.8, and 25.2 dB at 0.25, 0.5, 1, 2, 4, and 8 kHz, respectively. Mean thresholds of controls were 11.7, 8.8, 7.8, 6.2, 6.9, and 10.2 dB at 0.25, 0.5, 1, 2, 4, and 8 kHz, respectively.

Mean thresholds of better ears of MS patients were significantly higher than mean thresholds of controls at 0.5, 4, and 8 kHz (P=0.042, P=0.011, P=0.005, respectively). Mean thresholds of worse ears of MS patients were significantly higher than mean thresholds of controls at 0.25, 0.5, 1, 2, 4, and 8 kHz (P=0.01, P=0.003, P=0.002, P=0.000, P=0.000, P=0.000, respectively).

As shown in Table 3, in the age group (40-65), there was no significant difference in mean thresholds between MS patients and controls. However, in the age group (20-39), mean thresholds of better ears of MS patients were significantly higher than controls at 2, 4, and 8 kHz (P=0.046, P=0.004, P=0.005, respectively). Moreover, mean thresholds of worse ears of MS patients were significantly higher than controls at 0.5, 1, 2, 4, and 8 kHz (P=0.025, P=0.013, P=0.000, P=0.000, P=0.000, respectively).

There was no statistically significant correlation between MS duration and mean thresholds at any frequency, as shown in Table 4.

Table 4: Correlation between MS duration and mean thresholds across frequencies.

	MS Patients–Better Ear		MS Patients–Worse Ear	
Frequency (kHz)	rho	P value	rho	P value
0.25	0.137	0.3	0.06	0.636
0.5	0.098	0.461	0.18	0.17
1	0.248	0.058	0.11	0.393
2	0.035	0.794	0.21	0.114
4	0.078	0.557	0.25	0.053
8	-0	0.985	0.12	0.377

Discussion

This is the first study to assess hearing thresholds in MS patients in Jordan. The results showed significantly higher hearing thresholds than controls at all recorded frequencies. The effect was most prominent at high and low frequencies. Both ears were affected, but the effect was asymmetrically bilateral at mid-high frequencies and unilateral at low-mid frequencies.

Almost one third (N=21) of our MS patients complained of hearing difficulty or impairment. The degree of hearing impairment was mostly slight to mild (Table 2), which is similar to what have been reported in the literature [9, 15-18].

PTA thresholds of MS patients were most prominently elevated at high frequencies, followed by low frequencies, and then mid frequencies (Figure 1). These findings are in agreement with others in the literature reporting high- [8,15,16] and low- [6,9] frequency audiometric abnormalities in MS patients. However, there is no convincing explanation for the distribution of the thresholds alterations in MS [6].

The combination of unilateral and asymmetric bilateral effect of MS at different frequencies as shown in Figure 1 may indicate that the pathology of hearing effect of MS is due to involvement of the cochlea, the 8th nerve, and the brain stem at variable degrees [6].

Although hearing thresholds were most significantly affected at frequencies that are not usually used in daily life (0.25 and 8 kHz), almost one third of participating MS patients reported hearing difficulty in their daily lives. This may be attributed to impaired speech perception in MS patients despite normal PTA thresholds [19,20]. In our opinion, this speech perception impairment is mostly due to 8th nerve affection.

It appears that disease duration was not correlated with hearing thresholds (Table 4). This suggests that hearing impairments may have occurred as acute incidents instead of progressive and chronic decline in hearing status.

The present study had some limitations. In addition to the low sample size and unmatched controls in terms of age, we did not evaluate the treatment status for MS patients; especially, with new studies that came to the surface questioning the effect of interferon-Beta impact on PTA [21].

Conclusion

MS did affect hearing thresholds across all recorded frequencies (0.25-8 kHz). The effect was bilateral and asymmetrical at 0.5, 4, and 8 kHz and unilateral at 0.25, 1, and 2 kHz. Almost one third of MS patients complained of hearing difficulty/impairment; however, degree of hearing loss was mainly slight-mild. There was no correlation between hearing thresholds and disease duration in MS patients.

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