Hearing Statement in Multiple Sclerosis: A Case Control Study Using Auditory Brainstem Responses and Otoacoustic Emissions

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Abstract- Multiple Sclerosis (MS) is a demyelinating disorder of Central Nervous System. It involves 8th cranial nerve and its central nuclei and is an uncommon cause of the sensorineural hearing loss. For determining the prevalence of hearing loss (HL) especially retrocochlear type in MS, a cross-sectional study was designed using Pure-Tone Audiometry (PTA), Otoacustic Emissions (OAEs), Auditory Brainstem Responses (ABRs) compared with the control group. Data were analyzed by Qui^2 & Fischer exact test in SPSS 17 software. Among 60 patients (44 women & 16 men) and 38 controls (27 women & 11 men) with a mean age of 29.9±9.8 and 31.4± 8.3 years, 12.5% of case ears and 3.9% of the control ears had abnormal PTA (*P*= 0.043). Frequency of abnormal high frequency-PTA and two modalities of OAEs were not significantly different between case and control ears. The means of overall correlation were 75.9±23.8 in cases and 70.0±27.2 in controls (*P*= 0.111). 20% of case ears, and 9.2% of the control ears had abnormal ABRs (*P*= 0.044). The absolute latencies of waves I, II & V had not significant difference, but 10% and 11.7% of case ears and 1.3% & none of the control ears had increased inter peak latencies of I-III, and III-V respectively (*P*<0.05). 6.7% of case ears and 2.6% of control ears had retrocochlear abnormality (*P*=0.181). In conclusion, HL is more common in MS patients, especially when determined by using PTA and ABR.

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Keywords: Auditory brainstem Responses; Multiple Sclerosis; Otoacustic Emissions; Pure-Tone Audiometry; Sensory neural hearing loss

Introduction

Multiple Sclerosis (MS) is one of disorders of central nervous system (CNS) white matter that caused by an inflammatory demyelinating process. Its pathologic hallmark is plaques in white matter of the brain and/ or spine.

It usually presents as visual (optic neuritis), sensory (paresthesia, hypoesthesia, dysesthesia), motor (para paresis, hemiparasis), and cerebellar (ataxia, vertigo) symptoms. Also, cranial nerves- including 8th cranial nerve- are involved because of their nuclei involvement. 8th cranial nerve involvement presents with vestibular (ataxia, vertigo,etc…) and/ or partially or totally -usually unilateral hearing loss (1).

Sensory-neural hearing loss (SNHL) is a fairly common disorder that nearly always is due to cochlear dysfunction or less likely due to neural disorders (2). In the other words, the causes of SNHL are divided to cochlear and retrocochlear disorders and multiple sclerosis is under retro cochlear category (3).

Lee K.J. reported the prevalence of hearing loss among MS patients as high as 4-10% (2). In an Iranian study by using PTA and ABR this quantity was 22.2% and as a presenting symptom was 2.8%, and in another Iranian study by using PTA and SDS it was 40.2% (4,5).

Otoacoustic emissions (OAEs) are produced by biomechanical activity of cochlea, especially outer hairy cells (OHC) (2, 3). Recording these emissions is related to mechanical integrity of the outer ear canal, tympanic membrane and middle ear structures, and of course, sensory – neural hearing loss more than 30-40 dB can omit these waves (especially TEOAEs). In the other words, recording of OAEs in one ear with hearing

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threshold lower than 40dB is suggestive for cochlear and OHC health and neural and retrocochlear involvement (3).

Considering the different results of previous studies, we designed the new study by using OAE and Auditory Brainstem Responses (ABR) in addition to another audiological tests to determine the cochlear accuracy besides the prevalence of HL in MS cases, and to determine the prevalence of cochlear and retrocochlear HL among MS patients.

Materials and Methods

In this cross-sectional study 60 MS patients referred to a neurology clinic and MS Society of Guilan province of Iran, who fulfilled Mac Donald MS criteria 2005, and 38 healthy control subjects participated after completing informed consent. The control subjects were selected from the volunteered hospital staff and patients' accompaniments in trauma and orthopedics wards, and none of them had positive history and neurological exam compatible with MS.

All of the case and control subjects were younger than 50 years old. The subjects with acute otits media and coincident systemic disorders and any other diseases that cause SNHL-such as Wardenburg syndrome, Alport syndrome, idiopathic intracranial hypertension (IIH), vascular disorders such as vertebrobasilar insufficiency, dyscratic and rheologic disorders such as cryoglabulinemia and sickle cell anemia, and immunologic causes such as Cogan's syndrome and polyarteritis nodosa – and those with unreliable answers were not included in this study.

All of the subjects in the case and control groups were visited by a neurologist at first and then referred for otolaryngology examination, and performing the audiological tests including Pure Tone Audiometry (PTA) -Impedance Audiometry (IA), high frequency PTA, ABR and OAE (TEOAE and DPOAE) in a similar setting. Subjects with abnormal IA were excluded from the study.

According to PTA, abnormality was defined as increasing hearing threshold to more than 25 dB hearing level in one or more frequencies. ABR abnormalities were defined as increasing absolute latency of waves I, III and V to more than 2, 4 and 6 milliseconds, respectively, and I – III, III- V and I – V interpeak latencies (IPL) to more than 2.3, 2.3 and 4.4 msec. DPOAEs abnormality was defined as decreasing reproducibility of emissions and signal to noise ratio more than 3dB in each frequency, and TEOAE abnormality was defined as decreasing reproducibility of emissions in each frequency band to lower than 70%. Retrocochlear hearing loss was considered probable when PTA and ABR would be abnormal in the presence of normal OAEs. Efferent pathway involvement was defined as an abnormality of OAEs in the presence of abnormal ABR. Data was analyzed by and Qui^2 and Fischer exact test in SPSS.17 software.

Results

A total of 60 patients (44 women, 16 men, mean age: 29.86±9.8 years old), and 38 control subjects (27 women, 11 men, mean age: 31.39±8.3 years old) participated in this study. Both groups were adjusted for sex and age during sampling.

The mean duration of disease diagnosis in the case group were 3.2±2.9 years (4.2±3.3 yrs in men and 2.8±2.7 yrs in women). 88.3% of patients received one of MS prophylactic drugs. None of control subjects got the otovestibulotoxic drugs.

Impedance audiometers of all case and control subjects were normal. In the assessment of 196 ears, 15 ears (12.5%) in the case group and 3 ears (3.9%) in the control group had abnormal PTA (P= 0.043). This difference was significant in women (P= 0.02) but not in men (P=0.53) (Table 1).

According to involved frequencies, 10 ears had disturbances in 4000, and 8000 HZ and 5 ears in frequencies lower than 2000 HZ.

By using high frequency PTA, 79 ears (85.8%) in case group and 43 ears (56.6%) in the control group had abnormality (P=0.193) (Table 2).

Sixty two ears (51.7%) in the case group and 44 ears (59.5%) in the control group had abnormal TEOAE (P=0.29). The means of overall correlation were 75.9±23.8 and 70.0±97.2 in the case and control group respectively (P=0.111). The most prevalent (more than 32% of cases) involved frequency band was 3.5-4.5 KHz.

Also, 43 ears (33.8%) and 49 ears (66.2%) had abnormal DPOAE in the case and control groups respectively (P=0.000, but the preference was for the control group). The most prevalent frequency in both groups was 0.5 KHz, which it would be due to probable technical problems and environmental noise predominance. If considering other frequencies, a total of 10 case ears (8.3%) and 10 control ears (13.2%) had abnormal DPOAE (P= 0.27). Also the results of analysis in men and women populations were not statistically significant.

Table 1. Relative frequency of PTA abnormality among MS patients according to sex.

Sex				PTA Normal	PTA Abnormal	Total
Men[1]	Group	MS	N	28	4	32
			%	87.5%	12.5%	100.0%
		Control	N	20	2	22
			%	90.9%	9.1%	100.0%
		Total	N	48	6	54
			%	88.9%	11.1%	100.0%
women[2]	Group	MS	N	77	11	88
			%	87.5%	12.5%	100.0%
		Control	N	53	1	54
			%	98.1%	1.9%	100.0%
		Total	N	130	12	142
			%	91.5%	8.5%	100.0%

P_1=0.53, P_2=0.02

Table 2. Relative frequency of High Frequency PTA (HF-PTA) abnormality in MS.

			HF-PTA Normal	HF-PTA Abnormal	Total
Group	MS	N	41	79	120
		%	34.2%	65.8%	100.0%
	Control	N	33	43	76
		%	43.4%	56.6%	100.0%
	Total	N	74	122	196
		%	37.8%	62.2%	100.0%

P=0.193

Table 3. Relative frequency of efferent pathway involvement in MS.

			Efferent Normal	Efferent Abnormal	Total
Group	MS	N	10	14	24
		%	41.7%	58.3%	100.0%
	Control	N	3	4	7
		%	42.9%	57.1%	100.0%
	Total	N	13	18	31
		%	41.9%	58.1%	100.0%

P=0.642

In ABR examination the absolute latencies of waves I, III, and V had not significant difference in both groups, but 12 ears (10%) in the case group and 1 ear (1.3%) in the control group had increased I- III IPL (*P*=0.017), and 14 ears (11.7%) in the case group had increased III- IV IPL, but not any control subject had this abnormally (*P*=0.002). I-V IPL had been increased in 7 ears (5.8%) in the control group and 6 ears (5.9%) in the case group (P=0.572). Overally, ABR was abnormal in 20% of case group and 9.2% of the control group (*P*=0.044).

Considering abnormal PTA and ABR along with normal OAEs as retrocochlear hearing loss, 8 ears (6.7%) in the case group and 2 ears (2.6%) in the control group had retrocochlear involvement (*P*=0.181). Also efferent pathway involvement was seen in 58.3% and 57.1% of the case and control subjects respectively (*P*=0.642) (Table 3).

Discussion

There is multiple case reports about hearing loss in Multiple Sclerosis (8-12) but nearly all of them are based on PTA and/or ABR, and there isn't any assessment by use of high frequency PTA and OAEs, so that we don't have any knowledge about MS Patients cochlea.

In two studies in Iran, HL frequency in MS patients was determined 22.2% and 40.4% (4,5).

MS is one of the causes of SNHL and rarely SNHL is a presenting symptom of MS (7). Although according to pathophysiology of MS, hearing disturbance in these patients must be retro cochlear that is identified by ABR, but there may be cochlear abnormalities in MS (13,14). Theoretically we can think about reciprocal correlations between cochlear and retro cochlear pathways, and according to this, we can think about probability of cochlear disturbances in these patients.

Although there are many studies about afferent hearing pathways disturbances in MS, but there is few data about "efferent" pathways abnormalities in these patients (15). In a case report from Japan, a 24 years old woman with MS that was involved by heading loss and tinnitus underwent electricochleography and OAE that showed normal function of cochlea (16).

In another case report form USA in 2007, in a 12 years old girl with sudden SNHL and abnormal ABR and normal OAE, the assessments confirmed MS (17). Also in other study from UK, in 30 MS patients with normal hearing and 22 normal control subjects the function of efferent medial olivocochlear (MOC) pathway assessed by TEOAE was abnormal in 66.6% of patients, especially in whom with abnormality in brainstem. This study showed that MOC dysfunction in addition to afferent pathway involvement can explain hearing disturbances in MS patients that are not addressed before this (15).

In our study at least 16.7% and 5.3% of the case and control subjects had abnormal PTA in one side and totally, 12.5% and 3.9% ears of the case and control groups were abnormal based on PTA results (P=0.043). These results were lower than that of Bakshaee *et al*. study that was performed on 36 MS patients without a control group and without OAEs (4).

The most frequent involved frequencies were 4000 and 8000 HZ, and in the female population lower frequencies were involved more than male patients. According to ABR, 20% of ears in cases and 9.2% of ears in the control group had an abnormality that was significant (P<0.05). In Bakhshaee *et al*. study, 44.4% of patients had abnormal ABR. Albeit, the criteria of abnormality in their study were both abnormal latency and abnormal shape of the waves, that we didn't consider the last criterion in our study because of controversies existed in the literature about the accuracy of that, and this point may describe our different results compared with Bakhshaee study (4).

In Berjis *et al.* study in Isfahan (2005-2006) that was performed on 112 patients with the control group by use of PTA, the prevalence of SNHL in MS was determined 40.2% and 6.3% in the control group (5).

In our study, by use of high frequency PTA, 78.3% of cases had high tone (*i.e.* in frequencies more than 10,000 Hz.) sensorineural hearing loss at least in one side, although this high ratio was not statistically significant compared with the control group (P=0.101). One difference of our study with other studies is that we assumed more than 25 dB (instead of 20 or even 15 dB) decrease in hearing thresholds as abnormal both in the PTA and in the High frequency PTA, and this may decrease the prevalence of abnormal PTA in our patients.

By using OAEs (TEOAEs and DPOAEs), the MS patients (both sexes) didn't have cochlear involvement more than the control group. For example, in TEOAE, the mean overall correlations were 75.9±23.8% and 70.0±27.2% in the case and control groups respectively (P>0.05). It seems that OAEs, especially some parameters such as "DP signal noise ratio" in DPOAEs are not useful measures for determining hearing status in MS patients.

Totally, and considering PTA, ABR, and OAEs as measures for cochlear or retrocochlear involvement, 6.7% of case ears and 2.6% control ears had retro cochlear disturbances (P=0.181), although there may be clinically and "pathophysiologically" significant. Also we found that in 58.3% of cases who had abnormal ABR, OAEs (TEOAEs or/ and DPOAEs) were abnormal. Although this wasn't significant compared with the control group (P=0.642), but considering that in the control group only 4 out of 7 ears had this abnormality, so that only considering statistical difference cannot obviate important issue of influence of retrocochlear and "efferent" pathways on cochlear function in the mind of researchers. In conclusion, hearing loss is more prevent in MS patients especially by using high frequency PTA and ABR, but it does not seem that MS patients' cochlea are involved more than non MS subjects.

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References

1. Lublin FD, Miller AE. Multiple sclerosis and other inflammatory demyelinating diseases of the central nervous system. In: Bradley WG, Daroff RB, Fenichel GM, Jankovic J. Neurology in Clinical Practice. 5th ed. Philadelphia, Pa: Butterworth-Heinemann; 2008. p. 2026-42.

2. Lee KJ, editor. Essential Otolaryngology and Head and Neck Surgery. 8th ed. New York: McGraw-Hill; 2003. p. 44-53.
3. Arts HA. Sensorineural hearing loss: Evaluation and management in adults. In: Cummings CW, Flint PW, Harker LA, Haughey BH, Richardson MA, Robbins KT, Schuller DE, Thomas JR, editors. Cummings Otolaryngology: Head and Neck Surgery. 4th ed. St. Louis: Mosby; 2005. p. 3535-45.
4. Bakhshaee M, Forughipoor M, Esmaeili H, Rostami V, Razmara N. Involvement of the audiovestibular system in multiple sclerosis. Iranian J Otorhinolaryngol 2007;19(47):27-32.
5. Berjis N, Etemadifar M, Chitsaz A, Maleki M, Kadkhodaei A. Comparing the frequency of sensorineural hearing loss and neurological disorders, speech perception in patients with multiple sclerosis and healthy people. J Isfahan Univ Med Sci 2011;28(114):843-7. [Persian]
6. Shea JJ 3rd, Brackmann DE. Multiple sclerosis manifesting as sudden hearing loss. Otolaryngol Head Neck Surg 1987;97(3):335-8.
7. Franklin DJ, Coker NJ, Jenkins HA. Sudden sensorineural hearing loss as a presentation of multiple sclerosis. Arch Otolaryngol Head Neck Surg 1989;115(1):41-5.
8. Furman JM, Durrant JD, Hirsch WL. Eighth nerve signs in a case of multiple sclerosis. Am J Otolaryngol 1989;10(6):376-81.
9. Daugherty WT, Lederman RJ, Nodar RH, Conomy JP. Hearing loss in multiple sclerosis. Arch Neurol 1983;40(1):33-5.
10. Cianfrone G, Turchetta R, Mazzei F, Bartolo M, Parisi L. Temperature-dependent auditory neuropathy: is it an acoustic Uhthoff-like phenomenon? A case report. Ann Otol Rhinol Laryngol 2006;115(7):518-27.
11. Oh YM, Oh DH, Jeong SH, Koo JW, Kim JS. Sequential bilateral hearing loss in multiple sclerosis. Ann Otol Rhinol Laryngol 2008;117(3):186-91.
12. Cevette MJ, Robinette MS, Carter J, Knops JL. Otoacoustic emissions in sudden unilateral hearing loss associated with multiple sclerosis. J Am Acad Audiol 1995;6(3):197-202.
13. Grénman R. Involvement of the audiovestibular system in multiple sclerosis. An otoneurologic and audiologic study. Acta Otolaryngol Suppl 1985;420:1-95.
14. Fitzgerald DC, Mark AS. Sudden hearing loss: frequency of abnormal findings on contrast-enhanced MR studies. AJNR Am J Neuroradiol 1998;19(8):1433-6.
15. Coelho A, Ceranić B, Prasher D, Miller DH, Luxon LM. Auditory efferent function is affected in multiple sclerosis. Ear Hear 2007;28(5):593-604.
16. Nishida H, Tanaka Y, Okada M, Inoue Y. Evoked otoacoustic emissions and electrocochleography in a patient with multiple sclerosis. Ann Otol Rhinol Laryngol 1995;104(6):456-62.
17. Mallur PS, Lalwani AK. Fluctuating corticosteroid-responsive auditory neuropathy/dyssynchrony is suggestive of central nervous system pathology. Otol Neurotol 2007;28(8):1002-4.