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Original Article

Effect of hearing aid on balance

İşitme cihazı kullanımının denge üzerine etkisi

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ABSTRACT

Aim: The aim of this study was to investigate the effects of hearing aid usage on balance system in individuals older than 60 years of age who use hearing aid due to presbiacusia.

Materials and Methods: Individuals (>60 years of age) with at least 25 dB age-related sensorineural hearing loss in both ears and who were given bilateral hearing aid for 3 months were included to our study. The data obtained by evaluating balance system with cVEMP and Romberg on foam test prior to the usage of hearing aid and 3 months after individuals used bilateral hearing aid (without device condition) were compared.

Results: While P1-N1 responses were not taken from 21 of the tested ears, they were taken from 39 of the tested ears. Even though remarkable improvement was found in Romberg on foam test done after 3-month usage of hearing aid (p=0.001), no significant change was observed in cVEMP findings (p>0.05) other than the N1 latencies (p=0.03).

Conclusion: With the usage of hearing aid due to presciacusia, an increase is seen in the ability of keeping balance parallel with the increase in auditory inputs.

Key Words: Balance; Hearing aid; Presbiacusia; Romberg; VEMP.

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ÖZ

Amaç: Bu çalışmanın amacı presbiakuzi nedeniyle işitme cihazı kullanan 60 yaş üstü bireylerde işitme cihazı kullanımının denge sistemi üzerine olan etkilerini araştırmaktır.

Gereç ve Yöntemler: Çalışmamıza her iki kulağında en az 25 dB yaşa bağlı sensörinöral işitme kaybı olup 3 ay bilateral işitme cihazı verilen 60 yaş üzeri bireyler dahil edildi. Bireylerin işitme cihazı kullanmaya başlamadan önce ve bilateral işitme cihazı kullandıktan 3 ay sonraki cihazsız koşullarda cVEMP ve Romberg on foam test ile denge sistemini değerlendirerek elde edilen veriler karşılaştırıldı.

Bulgular: Test edilen kulakların 21'inden P1-N1 cevabı alınamazken, 39'undan P1-N1 cevabı alınmıştır. Üç ay işitme cihazı kullanımı sonrası yapılan Romberg on foam test de belirgin derecede düzelme saptanmasına rağmen (p= 0.001), N1 latansları (p = 0.03) dışında cVEMP bulgularında anlamlı bir değişiklik izlenmedi (p > 0.05).

Sonuç: Presbiakuzi nedeniyle işitme cihazı kullanımı ile işitsel inputların artmasına paralel olarak dengeyi sağlama becerisinde de artış görülmektedir.

Anahtar Kelimeler: Denge; İşitme cihazı; Presbiakuzi; Romberg; VEMP.

Introduction

The main duty of vestibular system is to ensure that the posture of body remains stable in space and to provide balance. For this, it is necessary to evaluate information from vestibular, visual and proprioseptive systems together and the organism should give responses compatible with this [1]

Along with ageing, weakness also occurs in our senses that have roles in ensuring hearing and balance, same as all systems. Presbiacusia and balance disorder are diseases that affect quality of life negatively, take long time to be treated and require expensive equipment like hearing aid. Balance disorder and hearing loss have become a widespread public health problem due to the gradually increasing elderly population and they grow in importance. Fractures, which cause severe morbidity, and even deaths can be seen in elderly people since they cannot keep their balance and fall [2,3].

Vestibular system and hearing organs have the same embryologic root. Thus, a disorder that occurs in function of a region may affect the other region developing from the embryologic same root [4].

In a the study which was conducted by Rumella et.al. within this scope, Romberg on foam test and the tandem stance test were performed for 14 patients above 65 years of age who had been using hearing aid for at least 3 months and it was stated that hearing aid provides improvement in ability of keeping balance [5].

We also planned this study to evaluate whether hearing aids have effect on balance or not. We studied on the effect of hearing aid usage on balance system by evaluating balance system in individuals above 60 years of age who use hearing aid due to presbiacusia prior to the usage of hearing aid and 3 months after they use bilateral hearing aid (without device condition) with cVEMP and Romberg on foam test.

Material and Methods

Individuals (>60 years of age) with at least 25 dB age-related sensorineural hearing loss in both ears and who were given bilateral hearing aid were included in this study between June 2015 and March 2016. Our study was approved by the local ethics committee, and conducted in accordance with the ethical principles of Declaration of Helsinki. Informed consent form was obtained from all participants before the study (Project No: 99950669/45).

Patients with cerebrovascular disease, degenerative neurologic disease, uncontrolled hypertension and arrhythmia and diseases related to balance were not included in the study.

The pure-tone audiometric (PTA) evaluation was performed using an AC-40 clinical audiometer (Inter acoustics, Assens, Denmark). The test of SDS was done with the usage of monosyllable phonetic balanced word lists (FD-300). In their audiometric tests, PTA thresholds in 500, 1000, 2000 and 4000 Hz frequencies, and a hearing aid fitting process was applied.

Cervical vestibular evoked myogenic potential (cVEMP) test was performed with Interacoustics Eclipse EP25 (Assens, Denmark) ABR equipment. Etymotic Research (ER-3A) insert

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earphones were used in cVEMP test. Tonic activation of sternocleidomastoid muscle (SCM) was ensured with head rotation through contralateral side of tested ear while patient was in sitting position. Following site isolation, reference (invert) electrodes were placed to 1/3 middle superior side of sternocleidomastoid muscle; active electrode (non-invert) was placed on the sternoclavicular joint where sternocleidomastoid muscle attaches to sternum. Ipsilateral SCM responses to monaural stimulation were recorded. Stimulation time was 5 ms, rise/fall time was 1 ms, high pass filter was 10 Hz, low pass filter was 3000 Hz. c-VEMP records were obtained at level of 500 Hz tonal stimulant and 5.1 pps rate at level of 100 dB HL with 60 ms analyze time and 200 sweep. Next, P1 and N1 wave controls were done at the lowest level with threshold screening method. Romberg on foam test was performed on an 8-cm thick foam floor for the patient, as eyes closed, feet together, arms placed as a cross on shoulders. Patient was expected to wait maximum 30 seconds in this position. In case of extreme swaying, moving arm or foot to maintain balance, opening eyes or falling, test was accepted as positive or symptom of Romberg and the standing time was recorded [5]

Balance system of individuals was evaluated prior to usage of hearing aid and 3 months after the usage (without device condition) with cVEMP and Romberg on foam test and the obtained data were compared.

NCSS (Number Cruncher Statistical System) 2007 (Kaysville, Utah, USA) program were used for statistical analyses. When study data was evaluated, definitive statistical methods; mean, standard deviation, median, frequency, rate, minimum and maximum values, were used. Student T test was used for two-group comparison of variables showing normal distribution. Evaluation of changes in measurements of variables consistent with normal distribution before and after the usage of device was done with Paired Samples test. Significance level was assigned as $p<0.01$ and $p<0.05$.

Results

Our study was conducted on total 30 patients, 43.3% of whom (n=13) were female and 56.7% of whom (n=17) were male. Age of patients range from 60 years to 76 years (median age = 64.37±3.58 years). VEMP measurements were done on total 60 ears as right and left ears of patients.

Patients pure tone thresholds of hearing range between 26 dB and 45 dB (mean = 32.18±4.88 dB). While P1-N1 responses were not taken from 35.0% (n=21) of the tested ears, they were taken from 65.0% of the tested ears (Table 1).

Table 1: Distribution of Definitive Features

Age (years)	Min - Max (Median)	60-76 (63,5)
	Mean±SD	64,37±3,54
Gender; n (%)	**Female**	13 (%43,3)
	Male	17 (%56,7)
Pure tone, threshold dB (n=60)	Min - Max (Median)	25-45 (31,5)
	Mean±SD	32,18±4,88
P1-N1 response (n=60); n (%)	**None**	21 (%35,0)
	Present	39 (%65,0)

Results for the Romberg on foam test, and mean P1 and N1 latencies and amplitudes of cVEMP are shown in Table 2. P1 latency measurements are 17.81±4.47 ms on average prior to the usage of device while this value is 17.62±4.31 ms on average after the usage of device. Mean 0.19±1.30 ms change occurred in P1 latency measurements after the usage of device in comparison with the measurements prior to the usage of device and this is statistically non-significant (p=0.368; p>0.05) (Table 2).

Table 2: Evaluation of Latency, Amplitude and Romberg Durations According to Device Usage

n=39		Device usage		p
		Before	**After**	
P1 Latency (ms)	Min – Max (Median)	10,4-25,4 (17,4)	9,7-26,8 (17,8)	0,368
	Mean±SD	17,81±4,47	17,62±4,31	
N1 Latency (ms)	Min – Max (Median)	18,6-37,2 (25,2)	18,6-36,0 (24,4)	0,030*
	Mean±SD	25,53±4,53	25,11±4,52	
P1-N1 amplitude (µV)	Min – Max (Median)	9,7-58,8 (27,6)	10,0-54,1 (30,6)	0,373
	Mean±SD	31,75±13,28	32,15±12,41	
Romberg duration (sn)	Min – Max (Median)	13,0-30,0 (20,0)	17,0-30,0 (23,5)	0,001**
	Mean±SD	19,90±4,29	23,33±3,40	
Paired Samples Test		*p<0,05	**p<0.01	

While N1 latency measurements are 25.53±4.53 ms on average before the usage of device, this value is 25.11±4.52 on average after the usage. Mean 0.42±1.15 ms decrease in N1 latency measurements after the usage of device comparing to before the usage of device is statistically significant (p=0.030; p<0.05) (Table 2 and Figure 1).

While P1-N1 amplitude measurements are 31.75±13.28 µV on average before the usage of device, this value is 32.15±12.41 µV on average after the usage. Mean 0.40±2.78 µV change occurred in P1-N1 amplitude measurements after the usage of device in comparison with the measurements prior to the usage of device and this is statistically non-significant (p=0.373; p>0.05) (Table 2).

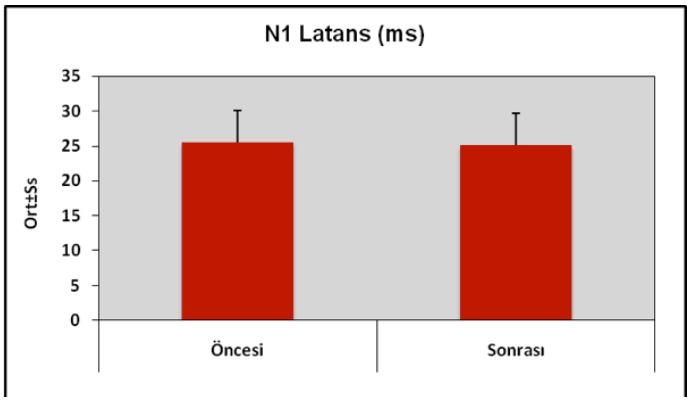
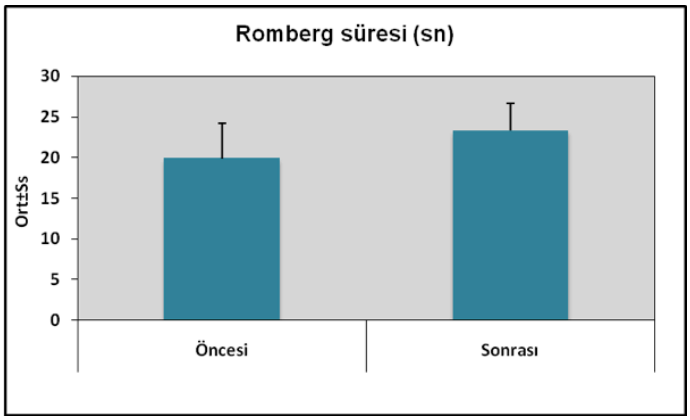


Figure 1: Change in N1 latency measurements

While Romberg on foam testing measurements are 19.90±4.29 sn on average before the usage of device, this value is 23.33±3.40 s on average after the usage. Mean 3.43±2.40 s increase in Romberg on foam testing measurements after the usage of device comparing to before the usage of device is statistically significant (p=0.001; p<0.01) (Table 2 and Figure 2).



Discussion

Although a remarkable improvement was found on Romberg on foam test in individuals above 60 years of age who suffer from age-related hearing loss after the bilateral usage of hearing aid for 3 months, no significant change occurred in cVEMP findings other than N1 latencies. This result shows that ability to keep balance increases parallel with the increase of auditory inputs with the usage of hearing aid.

The organs of auditory and vestibular system located in internal ear are remarkably similar to each other by means of both origin and function. The relation between hearing loss and vestibular system disorder is complicated and has not been completely solved yet.

It is known that saccule is tender to some kinds of auditory stimulants [6]. Although there is no predisposing factor which causes vestibular disorder to support this information, it has been stated that there can be decrease in vestibular functions in patients with age-related sensorineural hearing loss [4].

On a study conducted on individuals with noise-related hearing loss, abnormal VEMP findings have been found in 50% of them [7]

On another study, it has been stated that in children with advanced sensorineural hearing loss (SNHL), VEMP amplitudes decrease, however no significant change occurs in P1 and N1 latencies and vestibular system disorder exists in children with hearing loss [8].

On the other hand, the study conducted by Buchman et. al. has shown that patients for whom bilateral cochlear implant was placed significantly keep balance better than the patients with unilateral cochlear implant [9]. This study is very striking to understand that bilateral auditory inputs have much more significant role in keeping balance.

The study conducted by Rumella et. al. on this subject has made a major contribution to the literature. On the study, they evaluated the abilities of patients who use hearing aid for at least 3 months with and without the device by using Romberg on foam test and the tandem stance test. They made patients to close their eyes to prevent benefiting from visual clues and they gave the patients 65 dB wide-band white noise (0-4 kHz) during the test to determine the changes in balance ability with only auditory perception. As a result of the studies, they stated that hearing aid usage can be used as a new therapy modality in elderly patients with balance disorder [5].

We, on our study, evaluated the vestibular functions of patients with age-related hearing loss who have no vestibular complaint after a 3-month hearing aid usage with Romberg on foam test and cVEMP test. Apart from the conducted studies, we used cVEMP, which is an objective method, in evaluation of balance. We found out that patients keep their balance for longer time during the Romberg on foam test, similar to the literature.

On a recent study, N1 latency values range between 22.28-47.30 ms in patients with age-related hearing loss [4]. On our study this N1 latency value is in the range of 18.6-37.2 ms. Thus, even though the mean 0.42 ms decrease is statically significant for N1 latency value that can change in this wide range, we think that there is no clinically significant difference. We did not see a remarkable difference in P1 latency and amplitude changes after the usage of device comparing to before the usage. We observed that these values are consistent with normal values obtained in literature [10]. The reason of obtaining these results can be that a 3-month duration is a short time to obtain changes in cVEMP findings. The improvements obtained from Romberg on foam test scores, on the other hand, give raise to thoughts that the improvement in keeping balance is not ensured solely by the saccule functions but maybe the vision,

proprioceptive system, other parts of vestibular system and an improvement at cortex level (cortex processes this data and mainly ensures balance after usage of hearing aid), which all form this sysyem, also provide this.

Conclusion

In this study, we found out that hearing aid has positive effects on individuals who use bilateral hearing aid due to age-related sensorineural hearing loss. New studies to be performed with prospective control, multicenter approach, more patients and longer follow ups and with different balance tests will shed light on this subject.

Declaration of conflict of interest

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References

1. Highstein SM. The central nervous system efferent control of the organs of balance and equilibrium. Neuroscience research 1991; 12: 13-30.
2. Enrietto JA, Jacobson KM, Baloh RW. Aging effects on auditory and vestibular responses: a longitudinal study. Am J Otolaryngol 1999; 20: 371-78
3. de Mettelinge TR, Calders P, Palmans T et al. Vibration perception threshold in relation to postural control and fall risk assessment in elderly. Disability and rehabilitation 2013; 35: 1712-17
4. Kurtaran H, Acar B, Ocak E, Mirici E. The relationship between senile hearing loss and vestibular activity. Braz J Otorhinolaryngol 2016; 82: 650-53
5. Rumalla K, Karim AM, Hullar TE. The effect of hearing aids on postural stability. Laryngoscope 2015; 125: 720-23.
6. Todd NP, Cody FW, Banks JR. A saccular origin of frequency tuning in myogenic vestibular evoked potentials?: implications for human responses to loud sounds. Hear Res 2000; 141: 180-88
7. Wang YP, Young YH. Vestibular-evoked myogenic potentials in chronic noise-induced hearing loss. Otolaryngol Head Neck Surg 2007; 137: 607-11
8. Singh S, Gupta RK, Kumar P. Vestibular evoked myogenic potentials in children with sensorineural hearing loss. Int J Pediatr Otorhinolaryngol 2012; 76: 1308-11.
9. Buchman CA, Joy J, Hodges A, Telischi FF, Balkany TJ. Vestibular effects of cochlear implantation. Laryngoscope 2004; 114: 1-22
10. Su HC, Huang TW, Young YH, Cheng PW. Aging effect on vestibular evoked myogenic potential. Otol Neurotol 2004; 25: 977-80