Effects of earphone use on auditory evoked potential in college students

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Abstract- In this study, we analyzed the condition of earphone usage and volume according to the earphone users in their twenties. After analyzing them, Auditory Evoked Potential tests were conducted to identify problems with hearing loss of younger generations who are constantly exposed to portable audio devices and to prevent auditory disturbances. A questionnaire survey and Auditory Evoked Potential(AEP) test were performed on 54 students in twenties, 25 control subjects and 29 experimental subjects. Of the college students who participated in the questionnaire survey, 61-69dB in the control group and 85-113dB in the experimental group. As a research method, the active electrode was attached to the mastoid (M1, M2), the reference electrode was the crown (CZ), and the ground electrode was attached to the forehead (FPZ). When attaching the electrode to the scalp, the scalp was wiped clean with an abrasive to reduce the skin resistance at the time of the test by lowering the resistance between the scalp and electrode, and only the brain-induced dislocation was measured. The stimulation intensity was 70dB and 90dB, and total stimulation was stimulated 2000 times, resulting in 5 ~ 7 waves within 10m / sec. Therefore, the absolute latency time (AL) of I, III, and IV waves was measured because I, III, and IV waves, which are always recorded among the waves appearing through the averaging devices of signals, are treated most meaningfully. In the control group and the experimental group, there was no difference in the incubation period between the experimental group and the control group when the stimulation intensity was 90dB, but when the stimulation intensity was 70dB, the incubation period of the experimental group was delayed. In addition, the incubation of the experimental group was delayed and the conduction time to the inner ear was slower than that of the control group, and the incubation period according to the period of duration in the experimental group and the control group was not related. Therefore, the use of high-strength earphones is associated with auditory loss, which is likely to have a negative effect on the neural auditory cortex pathway. However, hearing loss was not associated with duration of period.

Keywords – Auditory Evoked Potentials(AEP), electrode, absolute latency (AL)

I. INTRODUCTION

Recently, portable audio devices have been developed due to hobbies such as music appreciation related to everyday life. Portable audio devices are small in size, easily store media through a computer, and have the advantage[1] of being able to use multiple media for a long period of time as the capacity of the battery increases. Thus, the exposure of new generation noise sources is rapidly increasing. In particular, teenagers and younger audiences can connect their earphones to a portable audio device to listen to music at a high volume, or to use the device for a long period of time. The sound of a portable audio apparatus is very powerful, and the potential for hearing loss may occur when used for a long period of time because it has a large influence on the most sensitive and important frequency band of 2000-4000 Hz in understanding the human auditory spectrum[2]. In Europe and the United States, the hearing loss of younger generations has become a social issue. To prevent this, the maximum volume of portable audio equipment is set at 100dB, and further efforts are being made to strengthen it to 85dB. In Korea, the maximum volume of portable sound devices sold in the market in Korea is 110 ~ 120dB, and a recommendation for limiting the maximum volume is being promoted[3]. In general, noise above 85dB may damage the inner ear, so it should not be exposed for more than 8 hours. Noise more than 115dB should not be exposed for a short time[4]. Hearing loss due to noise lowers not only the physical well-being but also the behavioral and social functioning status, furthermore, it also limits the daily activities and also significantly affects the stress symptoms such as anxiety, depression and cognitive disorder[5]. In addition, it may appeal to the tinnitus, which is anomalous sensation in the ear or head with no sound stimulus from the outside due to noise[6]. Tinnitus is one of the major symptoms of noise exposure and is accompanied by hearing loss[7]. Such tinnitus is not harmful to daily life when it is weak, but in severe cases it can cause not only hearing loss but also mental illness. About 30% of adults have tinnitus, 5% of adults are suffering from tinnitus, and 1% are seriously affected in one's life[8].

In this study, we analyzed the condition of earphone usage and volume according to the earphone users in their twenties. After analyzing them, Auditory Evoked Potential tests were conducted to identify problems with hearing loss of younger generations who are constantly exposed to portable audio devices and to prevent auditory disturbances.

II. PROPOSED ALGORITHM

A. Research subjects and prior homogeneity

The subjects were 54 students in twenties and 25 students in the control group and 29 students in the experimental group, and conducted Auditory Evoked Potentials(AEP). Of the college students who participated in the questionnaire survey, 61-69 dB in the control group and 83-113 dB in the experimental group. There were 19 males and 35 females, and there was no significant difference in the composition of gender between control group and experimental group. The duration of earphone usage was 9 or less for 5 years, 30 for 6 to 9 years, 15 for 10 years or more, and the control and experimental groups were composed of homogeneous groups(table 1).

Table -1 Study subjects and prior homogeneity

		Total	con.	exp.	χ^2(p)
N		54	25	29	
Volume (dB)			61-69	85-113	
Sex	Male	19	6	13	2.554(.155)
	Female	35	19	16	
earphones usage (year)	≤5	9	5	4	.417(.812)
	6-9	30	13	17	
	≥10	15	7	8	

B. Research method

A VIKINGIV computer system was used as the measuring instrument, and stranded sliver electrode and headphones which were used in the standard brain volumes were used as electrodes. Experimental pretreatment was conducted to remove obstruction factors (cell phone, fluorescent lamp, outlet) and maximize the electrical shielding by explaining the purpose, method and contents of the study to the subjects in the shielded room with earth connection, To exclude the effects of muscle tension, the subjects were placed in the most comfortable position and their eyes closed to relieve the maximum tension of the body.

The active electrode was attached to the mastoid (M1, M2), the reference electrode was the crown (CZ), and the ground electrode was attached to the forehead (FPZ) (Figure 1). When attaching the electrode to the scalp, the scalp was wiped clean with an abrasive to reduce the skin resistance at the time of the test, and then the electrode paste was attached by lowering the resistance between the scalp and electrode, and only the brain-induced dislocation was measured. After the headphone was loosely wrapped, a Rarefaction square wave click sound was applied to one ear in the order of stimulus intensity of 70dB and 90dB, while at the same time a 35dB shielding sound was applied to the opposite ear to block bone conduction. Stimulation. The total number of stimuli sound gave 2000 stimuli. In the frequency filter, the high filter is 3 KHz, the low filter is 100 Hz, and the sweep speed is 10 m / sec. Thus, when repeatedly applied with 2000 stimuli, 5 to 7 waves appear at 10 m / sec. After repeatedly checking at least twice through the averaging device of these signals, the incubation period of each summed average recorded wave was measured(Table 2). The absolute latency (AL) of I, III, and IV waves was measured because I, III, and IV waves that are always recorded are most significant among the waves appearing in the AEP test. The absolute latency time (AL) is the time from the stimulus point to the appearance of the reaction wave(Figure 2).

Table -2 Auditory Evoked Potential equipment conditions

Type	**Alternate**
Stimulus	Rarefaction square wave clicks
Intensity	70dB, 90dB
Rate	21Hz
High filter	3KHz
Low filter	100Hz
Amplification	2v
Sweep speed	10m/sec
Repetition No.	2000 회

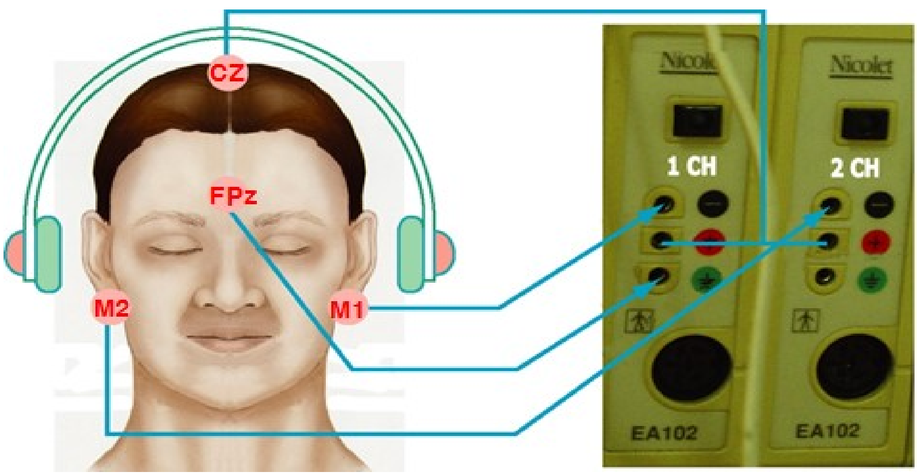

Figure 1. Auditory Evoked Potential electrode attachment method

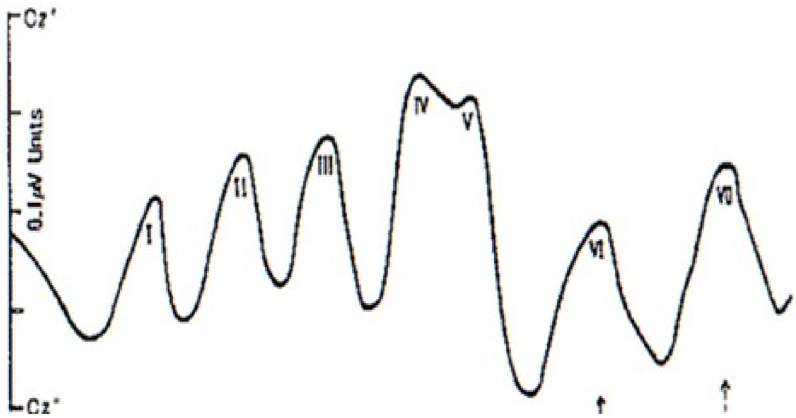

Figure 2. Absolute latency for each wave of auditory evoked potential

C. Analysis method

All data measured in this study were statistically processed using the statistical program SPSS 18.0. Corresponding sample T tests were conducted to compare the difference in absolute latency (AL) between the control and experimental groups according to the stimulation intensity (70dB, 90dB), between the stimulation intensity (70dB, 90dB). The mean and standard deviation were calculated for all the data obtained from the experiment, and all the variances were verified as significance $p < 0.05$.

III. Experiment and Result

A. Control for auditory evoked potentials – Experimental group comparison

The Auditory Evoked Potentials of the control group and the experimental group were not significantly different at the significance level of $p < .05$ at the stimulation intensity of 90dB(Table 3). At stimulation intensity of 70dB, the absolute incubation time of the control group and the experimental group was significantly shorter in the left and right sides of the control group than that of the experimental group in the I wave form. Incubation period(Table 4).

Table -3 Comparison of control-experimental group to auditory evoked potential according to 90dB

		Wave	Left Side			Right Side		
			Con. (M±SD)	Exp. (M±SD)	P-value	Con. (M±SD)	Exp. (M±SD)	P-value
90dB	AL	I	1.95±0.18	2.06±0.20	.057	1.99±0.12	2.03±0.19	.366
		III	4.19±0.28	4.23±0.31	.616	4.13±0.20	4.13±0.31	.998
		V	6.08±0.24	6.15±0.36	.416	6.11±0.24	6.20±0.30	.241

AL: Absolute Latency (ms)

Table -4 Comparison of control-experimental group to auditory evoked potential according to 70dB

Wave	Left Side	Right Side

			Con. (M±SD)	Exp. (M±SD)	P-value	Con. (M±SD)	Exp. (M±SD)	P-value
70dB	AL	I	2.03±0.13	2.42±0.33	<.001***	2.07±0.13	2.37±0.35	<.001***
		III	4.82±0.46	4.71±0.37	.324	4.66±0.31	4.76±0.35	.245
		V	6.78±0.35	6.90±0.43	.250	6.81±0.27	6.88±0.40	.431

AL: Absolute Latency (ms) *p<0.05, ***p<.001

B. Auditory Evoked Potentials according to group stimulus intensity

In the control group, the Auditory Evoked Potentials according to the stimulus intensity were significantly different in almost all waveforms, and when the stimulation intensity was increased to 90dB, the incubation period was shorter(Table 5). The Auditory Evoked Potentials according to the stimulus intensity in the experimental group showed a significant difference in almost all waveforms, and at 90dB from 70dB, the incubation period was shorter than that of the control group(Table 6).

Table -5 Auditory evoked potential according to stimulus intensity in control group

		Wave	Left Side			Right Side		
			90dB (M±SD)	70dB (M±SD)	P-value	90dB (M±SD)	70dB (M±SD)	P-value
Con.	AL	I	1.95±0.18	2.03±0.13	.038*	1.99±0.12	2.07±0.13	.009**
		III	4.19±0.28	4.82±0.46	<.001***	4.13±0.20	4.66±0.31	<.001***
		V	6.08±0.24	6.78±0.35	<.001***	6.11±0.24	6.81±0.27	<.001***

AL: Absolute Latency (ms) *p<0.05, **p<0.01, ***p<.001

Table -6 Auditory evoked potential according to stimulus intensity in experimental group

		Wave	Left Side			Right Side		
			90dB (M±SD)	70dB (M±SD)	P-value	90dB (M±SD)	70dB (M±SD)	P-value
Exp.	AL	I	2.06±0.20	2.42±0.33	<.001***	2.03±0.19	2.32±0.35	<.001***
		III	4.23±0.31	4.71±0.37	<.001***	4.13±0.31	4.76±0.35	<.001***
		V	6.15±0.36	6.90±0.43	<.001***	6.20±0.30	6.88±0.40	<.001***

AL: Absolute Latency (ms) *p<0.05, ***p<.001

C. Auditory Evoked Potential according to earphone use period

At the stimulation level of 90dB, the Auditory Evoked Potentials in the control group were significantly different only in the left side, and the incubation period of the user for 6 years or more in the absolute latency III waveform was longer than those in 5 years or less. In the incubation period I waveform, the incubation period was the longest when the period of use was less than 5 years(Table 7). When the Auditory Evoked Potentials were compared according to the duration of earphone use in the control group at stimulation intensity of 70dB, there was no significant difference(Table 8). In addition, the Auditory Evoked Potentials of the experimental group at the stimulation level of 90dB were significantly different in the absolute latency I waveform in the experimental group, and the latency of the user for 6 years or more was longer than those for 5 years or less(Table 9). However, the Auditory Evoked Potentials were compared according to the duration of earphone use in the experimental group at stimulus intensity of 70dB, there was no significant difference(Table 10).

Table -7 Auditory evoked potential according to earphone use period

		Wave	Left Side				Right Side			
			≤5 (M±SD)	6-9 (M±SD)	≥10 (M±SD)	P-value	≤5 (M±SD)	6-9 (M±SD)	≥10 (M±SD)	P-value
Con. (90dB)	AL	I	2.14±0.16	1.87±0.16	1.97±0.15	.010*	1.99±0.13	1.98±0.13	2.00±0.11	.955
		III	3.97±0.15	4.34±0.29	4.06±0.14	.008**	4.08±0.17	4.11±0.23	4.20±0.16	.531
		V	6.02±0.23	6.16±0.24	5.97±0.21	.208	6.07±0.23	6.17±0.26	6.02±0.18	.390

AL: Absolute Latency (ms) *p<0.05, **p<0.01, ***p<.001

Table -8 Auditory evoked potentials according to duration of earphone use in control group at 70dB

		Wave	Left Side				Right Side			
			≤5 (M±SD)	6-9 (M±SD)	≥10 (M±SD)	P-value	≤5 (M±SD)	6-9 (M±SD)	≥10 (M±SD)	P-value
Con. (70dB)	AL	I	2.10±0.13	2.02±0.14	2.00±0.09	.327	2.07±0.09	2.09±0.09	2.02±0.20	.566
		III	4.77±0.30	4.97±0.51	4.58±0.39	.198	4.68±0.43	4.67±0.29	4.61±0.30	.921
		V	6.73±0.22	6.84±0.40	6.68±0.37	.603	6.83±0.20	6.84±0.27	6.72±0.32	.650

AL: Absolute Latency (ms)

Table -9 Comparison of auditory evoked potentials according to duration of earphone use in experimental group at 90dB

		Wave	Left Side				Right Side			
			≤5 (M±SD)	6-9 (M±SD)	≥10 (M±SD)	P-value	≤5 (M±SD)	6-9 (M±SD)	≥10 (M±SD)	P-value
Exp. (90dB)	AL	I	1.86±0.13	2.13±0.20	1.99±0.17	.042*	2.04±0.18	2.04±0.16	2.00±0.26	.892
		III	4.23±0.30	4.27±0.38	4.16±0.07	.725	4.21±0.37	4.11±0.33	4.13±0.26	.854
		V	6.22±0.22	6.15±0.34	6.10±0.49	.886	6.25±0.37	6.18±0.30	6.21±0.30	.918

AL: Absolute Latency (ms) *p<0.05

Table -10 Comparing auditory evoked potentials according to earphone use time in experimental group at 70dB

		Wave	Left Side				Right Side			
			≤5 (M±SD)	6-9 (M±SD)	≥10 (M±SD)	P-value	≤5 (M±SD)	6-9 (M±SD)	≥10 (M±SD)	P-value
Exp. (70dB)	AL	I	2.29±0.35	2.40±0.31	2.54±0.37	.435	2.65±0.19	2.33±0.31	2.15±0.40	.062
		III	4.53±0.23	4.67±0.40	4.88±0.33	.231	4.75±0.29	4.83±0.25	4.63±0.54	.436
		V	6.96±0.31	6.86±0.41	6.96±0.55	.833	6.95±0.40	6.94±0.36	6.72±0.48	.403

AL: Absolute Latency (ms)

IV.CONCLUSION

A questionnaire and Auditory Evoked Potentials were performed in 54 college students using earphones to examine the stimulation intensity (70dB, 90dB) and the period of duration, and the following conclusions were obtained.
There was no difference in the incubation period between the experimental group and the control group when the stimulus intensity (90dB) was given to the control and experimental groups, but when incubated with the stimulus intensity (70dB), the incubation period of the experimental group was delayed. In addition, the incubation of the experimental group was delayed and the conduction time to the inner ear was slower than that of the control group, and the incubation period according to the period of duration in the experimental group and the control group was not related.
Generally, the stimulus intensity that damages the inner ear is 85dB. There was no difference in conduction time between subjects who were over a certain volume and subjects who were below a certain volume when they were given more stimulus to the subjects who were over or below a certain volume (85dB). However, when a small stimulus was given, the conduction time was later than that of the subjects who were under a certain volume, which was different from the conduction time. In addition, when using earphones, the subjects who are over a certain volume are slower in the conduction time to the inner ear than the subjects who are under a certain volume. And all subjects had no relationship between duration and conduction time. In other words, the use of high-strength earphones is associated with auditory loss, which is likely to have a negative effect on the neural auditory cortex

pathway[8]. However, it does not seem to affect the period. It is considered that the use of earphones with low strength will help to prevent other diseases.

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