

Does Long-Term Playing Violin Cause Unilateral Hearing Loss?

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Abstract

Objective: This study compared the differences between two ears, the one which is close to the violin and the far one from the violin, in individuals who have been playing violin, and evaluated by using Distortion Product Otoacoustic Emission.

Methods: 30 individuals between the ages of 18-30, playing violin for at least 2 hours a day for 5 years and having no history of hearing loss or ear diseases were included in the study. Pure tone audiometry test and Distortion Product Otoacoustic Emission test were applied on all subjects included in the study. The differences in these measurements for between two ears were subjected to statistical analyses.

Results: In all frequencies (996 – 7998 Hz) SNRs of the ear close to the violin and the ear far from the violin were obtained normal, above 6 dB SNR in the results of Distortion Product Otoacoustic Emission. However, there were not statistically significant differences between two ears ($p>0.05$), only at 1416 Hz a statistically significant difference was observed between the two ears ($p = 0.03$).

Conclusion: The violinists had better hearing function than expected. But noise-induced hearing loss happens slowly over time and may be hard to detect at first. Violinists are at risk for occupational exposure to high noise. Therefore, the violinists with normal hearing should be monitored by DPOAE which shows noise-induced damage in outer hear cells.

Keywords: *audiometry, otoacoustic emission, noise-induced hearing loss, violin, sound exposure*

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DOI: 10.17932/EJOH.2020.022/ejoh_v01i1004

Introduction

High noise level causes mechanical damage in the inner ear, usually causing biochemical and cell changes in the outer hair cells and cell damage in the nerve fibers. As a result, temporary or permanent noise-induced hearing loss may occur (1, 2). Prolonged exposure to low noise levels may have the same effect as short exposure to high noise levels. For example, listening to a 100 dB sound for 15 minutes will have the same effect as listening to a sound of 85 dB for 8 hours (3). Noise-induced hearing loss is the most common occupational disease in the USA. The average of 16% of adult hearing losses around worldwide are caused by occupational exposure to high noise (4).

The function of outer hair cells damaged by noise is evaluated by the otoacoustic emission test. With the otoacoustic emission test, very small intensity sound waves originating from the outer hair cells in the cochlea are recorded with a sensitive microphone placed in the external ear canal. There are two types of otoacoustic emissions used for clinical testing: transient evoked otoacoustic emissions (TEOAEs) and distortion product otoacoustic emissions (DPOAEs). DPOAEs are used to obtain frequency-specific data regarding cochlear sensitivity (5). For DPOAE measurements, the signal-to-noise ratio (SNR), which is a measure of the level of DPOAEs, should be 6 dB and above. Studies have demonstrated that noise exposure can lead decrease results of DPOAEs (6, 7).

Since musical instruments produce very loud sounds, they may cause hearing loss. Musicians are averagely exposed to sounds of 79-98 dB intensity during concerts and rehearsals. This intensity is in the range of 85-105 dBA in individuals who play the violin, which is the most well-known instrument of the stringed instrument family (8). Violin's fundamental frequencies are 196-3136 Hz, and its harmonics are in the range 4-15 kHz. While playing the violin, the intensity of the sound emanating from the instrument is harmful for the ear which is close to the violin (9). It was observed that the left ear of musicians using string instruments was exposed to an average of 4.6 dBA sounder than their right ears (8).

The aim of this study was to compare the differences between two ears, close to violin and the far one from the violin, in individuals who have been playing violin and evaluated by using DPOAE.

Material and Methods

The study was conducted in Istanbul Aydın University Faculty of Health Sciences Audiology Laboratory between April and May 2019. It was approved by the Istanbul Aydın University Non-Interventional Clinical Research Ethics Committee (registration number 2019/77) on April 25th, 2019. 30 individuals, 5 males and 25 females, between the ages of 18-30 were included in the study.

Inclusion criteria were determined as playing the violin for at least 2 hours a day for 5 years and having no history of hearing loss or ear diseases. External auditory canal pathologies, perforation in the eardrum, congenital ear anomalies are defined as an exclusion criteria. Otolaryngologic examination was performed on all subjects included in the study, and Pure tone audiometry (PTA) test and DPOAE test were applied. DPOAE results were compared between the ear close to violin and the far one from the violin.

Audiometric evaluation

PTA was performed with Otometrics Madsen Astera model device. It was performed following audiometric evaluation procedures in a standard silent cabin complying with ANSI standards. Air conduction evaluations has been performed using Telephonic TDH-39 (Telephonics, USA) headphones in the range of 0.25-8 kHz, and bone conduction evaluations using a Radioear B-71 (Radioear, USA) brand bone conduction vibrator in the range of 0.5-4 kHz. Pure tone average (PTA) were calculated by using the hearing thresholds at frequencies of 500, 1000, 2000 Hz, and Godmann's classification (0 -25 dB HL normal hearing, 26 -40 dB HL very mild hearing loss, 41 -55 dB HL mild hearing loss, 56 -70 dB HL moderate hearing loss, 71 -90 dB HL severe hearing loss, 91 and above dB HL very severe hearing loss) for both ears.

Otoacoustic Emission Test

DPOAE test was evaluated using Otometrics Madsen Capella model device and a bandwidth in the range of 1-8 kHz was selected. 65 dB SPL at L1 and 55 dB SPL at L2 were used. Two pure tones (F1 and F2) were used as acoustic stimuli. The SNR value was used as 6 dB intensity. DPOAE test results were evaluated according to the SNR value at 13 different frequencies (996, 1191, 1416, 1679, 2001, 2382, 2832, 3359, 4003, 4755, 5654, 6728, 7998 Hz).

Statistical Analysis

Whether there is a difference between the results of the ear close to violin and the far one from the violin is tested with Paired T test for the samples which has normal distribution, and with Wilcoxon Signed Ranks Test for the samples which has not normal distribution. A value of $p < 0.05$ was considered the limit of significance. The normality of the distribution will be tested with the Shapiro-Wilk test. The homogeneity of variances will be tested with Levene Test. In cases where the data are normally distributed and the variances are homogeneous, the Wilcoxon Signed Ranks test will be applied. SPSS 22.0 package program will be used for data analysis.

Results

This study examined 30 individuals (25 females and 5 males), aged between 18 and 30 ($22 \pm 2,19$) years old (mean $24,10 \pm 5,46$). One subject held the violin close to their right ear, and 29 (96.7%) held the violin close to their left ear. As analyzing the anamnesis taken 11 individuals (36.7%) had tinnitus and 19 individuals (63.3%) had no tinnitus; one (3.3%) The individuals included in the study have been playing the violin for 7.47 ± 2.67 years, with an average of 4.07 ± 1.43 hours a day. As the result of the pure tone audiometry test, the degrees of hearing of 30 individuals were determined normal. There were not statistically significant differences between two ears ($p > 0.05$). Individuals' pure tone thresholds of the ears close to the violin and the ears far from the violin are shown on the Figure 1.

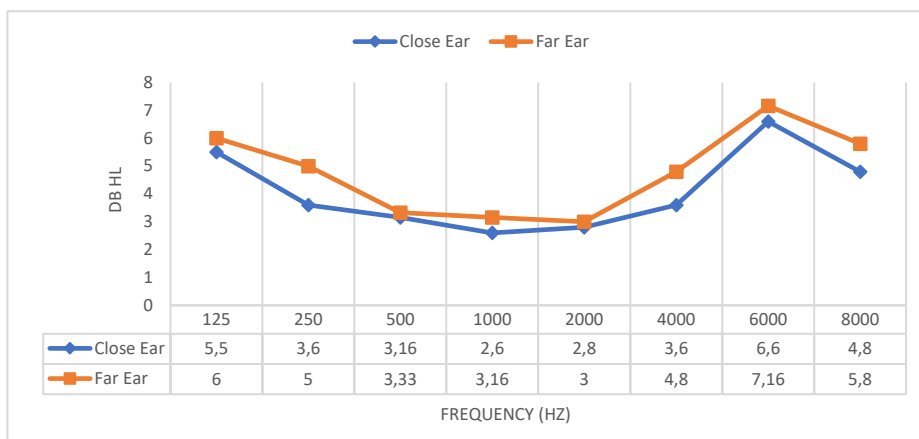


Figure 1: Pure tone threshold means of the ear close to the violin and the ear far from the violin

As the result of the DPOAE test, SNR of 30 individuals was compared. Since SNR values at 996 Hz data were not normally distributed, they were compared with the Wilcoxon Signed Ranks test. SNR values at 1191 Hz, 1416 Hz, 1680 Hz, 2002 Hz, 2383 Hz, 2832 Hz, 3359 Hz, 4003 Hz, 4756 Hz, 5654 Hz, 6729 Hz 7998 Hz were compared with the Paired T test. In all frequencies, SNRs of the ear close to violin and the ear far from the violin were determined above 6 dB (Table 1). However, a statistically significant difference was observed between the two ears at 1416 Hz ($p = 0.03$).

Table 1: SNR comparison of DPOAE of ears close and far from the violin

Frequency	Close Ear		Far Ear		Sig (2-tailed)
	Mean ± Sd	Min - Max	Mean ± Sd	Min - Max	
996 Hz	15.53 ± 6.60	7 - 27	16.36 ± 6.15	6 - 27	,437
1191 Hz	17.63 ± 6.91	6 - 32	17.70 ± 7.95	1 - 31	,961
1416 Hz	16.40 ± 6,54	6 - 30	18.60 ± 5.78	8 - 28	,031*
1679 Hz	16.93 ± 6.69	3 - 30	16.57 ± 6.59	0 - 27	,692
2001 Hz	15.33 ± 6.67	0 - 30	14.06 ± 5.92	-1 - 25	,381
2382 Hz	12.53 ± 4.28	3 - 24	11.8 ± 4.77	-4 - 22	,758
2832 Hz	13.00 ± 5.03	3 - 24	12.26 ± 5.50	0 - 23	,824
3359 Hz	15.56 ± 5.07	8 - 24	16.8 ± 5.46	7 - 27	,248
4003 Hz	14.46 ± 4.25	8 - 23	13.9 ± 5.98	-2 - 26	,703
4755 Hz	11.83 ± 6.35	-3 - 21	11.46 ± 6.23	-9 - 29	,831
5654 Hz	12.23 ± 5.88	1 - 26	11.03 ± 6.55	-2 - 23	,427
6728 Hz	12.86 ± 5.89	-5 - 24	10.96 ± 7.00	-9 - 27	,294
7998 Hz	8.33 ± 4.47	-4 - 18	8.5 ± 7.28	-7 - 19	,890

Discussion

The presence of unilateral hearing loss in individuals exposed to violin noise for a long time was investigated in this study. The SNR value differences between two ears, close to the violin and the far one from the violin were compared by DPOAE at each frequency in the range of 996 – 7998 Hz.

In the literature there are studies about the evaluation of hearing loss due to the noise in musicians. In a research paper, investigated the presence of noise-induced hearing loss in individuals playing violin. In the study, individuals playing violin were evaluated just before and after playing the violin, temporary hearing loss was found at 4 kHz on left ear both at pure tone threshold and TEOAE tests (8). Schmidt et al. (8) were obtained that first violinists had a slightly worse hearing on the left ear compared with the right ear, for high frequencies. In our study, hearing thresholds and DPOAE results were normal in both ears. However, statistically significant difference was observed between the two ears at 1416 Hz of DPOAE while violinist PTA at 1416 Hz was normal. At the basis of the

knowledge that is violin's fundamental frequencies are between 196-3136 Hz, this may be explained violin's should be monitored with via DPOAE even if PTAs are normal. On the other hand, another explanation of this result may be that audiological test results were considered to be normal since individuals were not evaluated immediately after noise exposure or permanent hearing loss has not yet occurred as it causes temporary hearing loss.

The OSHA hearing conservation amendment mandates audiometric surveillance of workers who are exposed to noise levels equal to or exceeding 85 dBA on an 8-hour time-weighted average (10). There are different results in the literature regarding the sound level which violinists are exposed. Schmidt et al. (11) determined that there was exposure to 95–96 dB in the left ear and 89–92 dB in the right ear. In another study the ranges of average sound levels were 86-93 dB(A) for violins and violas (12). Playing the violin for 2 hours a day, which is our inclusion criteria, may not be sufficient hour to cause hearing loss. Occupational standards specify a maximum allowable daily noise dose, expressed in percentages. For example, a person exposed to 85 dBA per NIOSH or 90 dBA per OSHA over an 8-hour work shift, will reach 100% of their daily noise dose. %100 noise dose for 2 hours is 91 dBA per NIOSH or 100 dBA per OSHA (13, 14).

In conclusion, the violinists had better hearing function than expected. But noise-induced hearing loss happens slowly over time and may be hard to detect at first. Violinists are at risk for occupational exposure to high noise. Therefore, violinists with normal hearing should be monitored by DPOAE which shows noise-induced damage in outer hear cells.

This study was limited by the relatively small sample size. A larger sample size might have led to significant differences. In addition, while evaluating hearing loss, the sound exposure of violin should be determined in both ears. Future studies should examine hearing function by classifying violin players by work experience (in years) and the number of normal working hours per week.

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