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Research Paper

Assessment of rock musician's efferent system functioning using contralateral suppression of otoacoustic emissions

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Rock musicians;
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Abstract *Objective:* Contralateral suppression of oto acoustic emission (OAE) is referred as activation of efferent system. Previous literature mentioned about the importance of contralateral suppression of OAEs as a tool to assess efferent system in different groups of population. There is dearth of literature to explore the efferent system function in experienced musicians exposed to rock music using TEOAEs and DPOAEs.
Methods: Two groups of participant (14 rock musicians and 14 non-musicians) in the age range of 18–25 years were involved in the study. Contralateral suppression of TEOAEs and DPOAEs were measured using ILO (Version 6) in both groups.
Results: Descriptive statistics showed higher suppression of TEOAEs and DPOAEs in rock-musicians at most of the frequencies in comparison to non-musicians. For DPOAE measures, Mann Whitney *U* test results revealed significantly greater DPOAE suppression only at 1 kHz and 3 kHz in rock-musicians compared to non-musicians. For within group comparison, Kruskal Wallis test results revealed there were significant difference observed across most of the frequencies i.e. at 1 kHz, 3 kHz and 6 kHz. For TEOAE measures, Mann Whitney *U* test results revealed that only at 2 kHz, TEOAE suppression in rock-musician was significantly greater compared to non-musicians. Similarly, Kuskal Wallis test results revealed that within group

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there were no significant differences observed for most of the frequencies except 2 kHz.
Conclusions: Based on the above finding, present study concludes that rock musicians are having better efferent system compared to non-musicians. No suppression effect at few frequencies probably indicates more vulnerability at those frequencies. Contralateral suppression of DPOAE shows more significant finding in comparison to contralateral suppression of TEOAEs in present study.

Introduction

The auditory efferent system consists neural pathways that transmit information from the lower brainstem to the cochlea.[1] The medial component consists of large, myelinate fibres that originate around the medial nuclei of the superior olivary complex and terminates beneath the outer hair cells (OHCs) of the organ of corti.[1,2] Some medial olivocochlear neurons project ipsilaterally and some project contralaterally, with most OHCs having binaural input.[3] On acoustic stimulation, the medial olivocochlear system (MOCS) inhibits activity of OHCs which can be seen by a decrease in the level of OAEs in normal hearing individuals.[4,5] The amount of suppression can be measured by subtracting the level of emission in presence of the suppressor stimulus from the level of emission in absence of suppressor stimulus.

The function of MOCS is not completely understood by the researchers but in attempts to further understand its function, various psychoacoustic measures such as loudness adaptation and ability to understand speech in presence of noise have been studied in relation to MOCS.[6,7] The other approach to uncover its functionality has been to study MOCS differences among different subject population.

Studies very clearly mentioned about the importance of contralateral suppression of OAEs in different groups of population.[8–12] Since suppression of emissions is referred as activation of efferent system which indicated the amount of protection exists with the individuals. It is well known fact that measuring emissions is less time consuming, non-invasive and precise measures due to which many researchers preferred to use it for evaluating efferent system using this technique. In spite of wide application, there is a dearth of literature to explore the efferent system function in experienced musicians exposed to rock music using TEOAEs and DPOAEs. Though, it has been reported in other electrophysiological studies that musicians have enhanced perceptual skills compared to the non-musicians,[13–17] combination of TEOAEs and DPOAEs suppression effects is not widely explored in rock musicians. Hence, present study is formulated to measure the functioning of efferent system in experienced rock musicians to know about the role of OCB in these individuals over non-musicians. The aim of the present study is to assess the functioning of efferent system in experienced rock musicians in comparison to non-musicians using contralateral suppression of TEOAEs and DPOAEs.

Material and method

Participants

Two groups of participant (experimental & control group) in the age range of 18–25 years were involved in the study. Experimental group includes 14 rock musicians (28 ears) (Mean age of 23.3 ± 1.3 year) who had minimum professional experience of 5 years of rock music exposure (Mean duration of 8.4 years), practicing minimum of 15 h per week (Mean = 19.3 h/week). They had started musical training after the age of 10 years. Further age matched 14 participants (28 years) (Means age of 24.7 ± 2.1 years) who were not having any formal training of any kind of music and never participated in any musical related activities strictly served as non-musicians, in the control group. All the participants had pure tone thresholds less than 15 dB HL in both ears, which indicated normal peripheral hearing system in both ears. They had no indication of middle ear pathology on the day of testing as per immittance evaluation. They were ruled out based on structured case history for any history of diabetes mellitus, hypertension, any neurological disorders, smoking, and consuming alcohol. It was insured that participants were not having illness on the day testing.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the All India Institute of Speech and Hearing ethical committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Written Informed consents was taken from all participants of this study.

Instrumentation

A calibrated Grason-Stadler Incorporated-61 (Grason-Stadler, Eden Prairile, United State of America) dual-channel audiometer with Telephonics TDH-50P supra-aural headphones, housed in MX-41/AR ear cushions, was used for obtaining air-conduction thresholds. The same audiometer with Radioear B-71 bone-vibrator was used for obtaining bone-conduction thresholds. A calibrated GrasonStadler Incorporated Tympstar (GrasonStadler, Eden Prairile, USA) immittance meter, with default probe assembly and contralateral earphone, was used for tympanometry and reflexometry. ILO (Version 6) was used for OAEs tests.

Test environment

The testing was carried out in an acoustically sound treated room with ambient noise levels within permissible limits as per ANSI S3.1 (1991). Pure-tone audiometry was carried out in a two-room set up while tympanometry and OAEs tests were administered in a single room suite.

Procedure

The detailed structured case history was obtained from each participant to meet the above subject selection criteria. Pure tone thresholds were obtained using modified Hughson and Westlake procedure at different octave frequencies in between 250 Hz and 8 kHz for air conduction thresholds and for bone conduction thresholds in between 250 Hz and 4 kHz. Tympanometry was done on all participants using 226 Hz probe tone frequency and acoustic reflexes were measured at 500 Hz, 1 kHz, 2 kHz and 4 kHz for both ipsilateral and contralateral measures.

TEOAEs and DPOAEs absolute thresholds as well as contralateral suppression of TEOAEs and DPOAEs were measured using ILO (Version 6). A standard TEOAE/DPOAE probe tip was positioned in the individual's ear canal. For DPOAEs recording, throughout the measurement the ratio (f2/f1) was kept constant i.e. 1.22. The stimulus intensity levels were also held constant at L1 = 65 and L2 = 55 dBSPL. The levels of the 2f1−f2 DPOAE were depicted as a function of frequency as a DPgram in between 1000 Hz and 6000 Hz. TEOAE/DPOAE were considered to be present when they were at least 3 dB above the corresponding noise level.[18] The contralateral broad band noise was generated by the Grason-Stadler Incorporated-61 diagnostic audiometer at 60 dBSPL and presented in contralateral ear as it does not evoke the middle ear reflex.

Results

Descriptive statistics of DPOAEs and TEOAEs suppression amplitude in musicians at all frequencies in comparison to non-musicians shown in Tables 1 and 2 respectively. In addition, Kruskal Wallis test was used within group comparison across frequencies and Mann Whitney *U* test was done to check the significant differences between two groups for each test.

For DPOAE measures, Mann Whitney *U* test results revealed that there were significant differences between two groups for DPOAE suppression at 1 kHz ($Z = -2.276$, $P < 0.05$), 3 kHz ($Z = -2.00$, $P < 0.05$). However, significant differences were not observed at 1.5 kHz ($Z = -0.253$, $P > 0.05$), 2 kHz ($Z = -0.184$, $P > 0.05$), 4 kHz ($Z = -0.667$, $P > 0.05$) and 6 kHz ($Z = -0.664$, $P < 0.05$). For within group comparison across frequencies, Kruskal Wallis test results revealed there were significant difference observed for the frequencies i.e. at 1 kHz ($Z^2 = 7.23$, df = 1, $P < 0.05$), 3 kHz ($Z^2 = 10.85$, df = 1, $P < 0.05$) and 6 kHz ($Z^2 = 6.80$, df = 1, $P < 0.05$). However, significant differences were not noticed at 1.5 kHz ($Z^2 = 2.15$, df = 1, $P < 0.05$), 2 kHz ($Z^2 = 2.17$, df = 1, $P < 0.05$) and 4 kHz ($Z^2 = 1.67$, df = 1, $P < 0.05$). Mean amplitude and standard deviation for contralateral suppression of DPOAE among rock-musicians and non-musicians is given in Table 1.

For TEOAE measures, Mann Whitney *U* test results revealed that the suppression was not statistically significant at all frequencies except 2 kHz ($Z = -2.114$, $P < 0.05$). For within group comparison across frequencies, Kruskal Wallis test results revealed that there were no significant differences observed for most of the frequencies except 2 kHz ($Z^2 = 8.47$, df = 1, $P < 0.05$). Mean amplitude and standard deviation for contralateral suppression of TEOAE among rock-musicians and non-musicians is given in Table 2.

Discussion

Present study aimed to assess the functioning of efferent system in experienced rock musicians in comparison to non-musicians using contralateral suppression of TEOAEs and DPOAEs. Contralateral suppression of TEOAEs and DPOAEs were measured in rock musicians and non-musicians. Descriptive statistics showed higher suppression of TEOAEs and DPOAEs in musicians at most of the frequencies in comparison to non-musicians. For DPOAE measures, Mann Whitney *U* test results revealed significantly greater DPOAE suppression at 1 kHz and 3 kHz in musicians compared to

Table 1 Contralateral suppression of DPOAE at different frequencies between rock-musicians and non-musicians group (dB, Mean ± SD).

Group	1 kHz	1.5 kHz	2 kHz	3 kHz	4 kHz	6 kHz
Rock musicians	4.84 ± 3.96	3.80 ± 5.67	3.74 ± 3.82	3.17 ± 2.17	3.75 ± 3.22	3.22 ± 4.19
Non-musicians	2.30 ± 2.65	2.72 ± 4.33	3.05 ± 3.57	1.00 ± 3.27	2.80 ± 2.81	1.84 ± 1.83

Table 2 Contralateral suppression of TEOAE at different frequencies between rock-musicians and non-musicians group (dB, Mean ± SD).

Group	1 kHz	1.5 kHz	2 kHz	3 kHz	4 kHz
Rock musicians	2.53 ± 2.32	4.01 ± 3.21	3.30 ± 2.62	2.47 ± 2.24	1.83 ± 2.08
Non-musicians	3.54 ± 3.37	3.13 ± 2.50	1.18 ± 2.87	1.68 ± 1.73	1.32 ± 1.15

non-musicians. However, significant differences were not observed at 1.5 kHz, 2 kHz, 4 kHz and 6 KHz. Kruskal Wallis test results revealed there were significant difference observed across most of the frequencies i.e. at 1 kHz, 3 kHz and 6 kHz. However, significant differences were not noticed at 1.5 kHz, 2 kHz and 4 kHz.

For TEOAE measures Mann Whitney *U* test results revealed that though there were higher suppression (better MOC system) for musicians in comparison to non-musicians it was not statistically significant at all frequencies except 2 kHz. When comparisons were made between two measures, DPOAE shows more of frequencies with significant difference in comparison to TEOAEs in present study. Probably DPOAEs could able to tap the minimal differences observed between experienced musicians versus non-musicians.

Outcome of the present study is in consonance with previous literature.[7,19–21] Micheyl et al.[7] in 1995 investigated suppression of TEOAEs under contralateral acoustic stimulation in musicians and non-musicians. The result showed that the musicians showed on average a greater reduction in TEOAE amplitude under contralateral acoustic stimulation, suggesting a stronger medial efferent feedback on the auditory periphery in these subjects. Similarly, Perrot et al.[19] in 1999 compared contralateral suppression of OAEs between professional musicians and non-musicians. They also reported stronger bilateral cochlear suppression, suggesting larger efferent influences in both ears, in musicians. Micheyl et al.[20] in 1997 also reported that musicians showing greater amplitude reduction of evoked otoacoustic emission upon contralateral noise stimulation than non-musicians. On similar line, Brashears et al.[21] in 2003 studied contralateral suppression of TEOAEs on orchestra musicians using binaural broad band noise in a forward masking paradigm. Result revealed orchestra musicians to have significantly more suppression compared to non-musicians. The probable reason for the higher suppression effect explained as sound conditioning stimulus and music could be the mechanism for strengthening central auditory pathways. Sound conditioning has been shown to ameliorate the damaging effect of noise trauma in various animal models.[22,23] MOC is well known as protective functional role appeared to share by "toughening" of OHCs themselves.[24] Further, present study finding such as more suppression effect in rock musicians could be explained as constant dose of low level noise exposure in the form of music may be conditioning the musician ears and thus increased ability to suppress otoacoustic emissions. The differences across frequencies in terms of suppression effects could be explained as more/less vulnerable auditory system to the noise in musicians. The results of the present study revealed higher suppression effect across frequencies in musicians though not significant, which probably indicate better protection to the auditory system across different frequencies in these individuals. However, no suppression effect at most of the frequencies probably indicates more vulnerability at those frequencies. Based on the above finding, present study concludes that musicians are having better efferent system but needs to be validated on larger population and with more experience of music training.

Conclusion

The results of the present study revealed higher suppression effect across frequencies in musicians, which probably indicates better protection to the auditory system across different frequencies in these individuals. However, no suppression effect at few frequencies probably indicates more vulnerability at those frequencies. Based on the above finding, present study concludes that rock musicians are having better efferent system compared to non-musicians.

Conflicts of interest

None.

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