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Evaluation of Acoustic Reflex and Reflex Decay Tests in Geriatric Group

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Original Investigation

Abstract

Objective: To determine average acoustic reflex thresholds in geriatric groups by assessing ipsilateral and contralateral acoustic reflex and reflex decay tests.

Methods: A total of 25 elders between ages 65-84 years (74.3±5.4) and 25 individuals between ages 18-45 years (30.4±4.2) were recruited for the study. After ear, nose, and throat examination, ipsilateral and contralateral acoustic reflex thresholds at 500, 1000, 2000, and 4000 Hertz (Hz) were determined and a reflex decay test at contralateral 500 Hz was conducted. Ipsilateral acoustic reflex thresholds were obtained with high-frequency band, low-frequency band, and wide band noise, and the results were compared with ipsilateral acoustic reflexes at 500, 1000, 2000, and 4000 Hz.

Results: There was no statistically significant difference between the two groups in ipsilateral and contralateral acoustic reflex measurements at 500, 1000, 2000, and 4000 Hz (p>0.05). Negative reflex decay was obtained in all participants and no statistically significant difference between the two groups was observed in terms of reflex decay thresholds (p>0.05). Acoustic reflex with high-frequency band noise was observed in five of nine elders whose acoustic reflexes were not obtained at 2000 and 4000 Hz, whereas acoustic reflex with low-frequency band noise was observed in one of six elders who did not show reflexes at 500 and 1000 Hz.

Conclusion: It was concluded that although some changes were observed due to age, middle ear and stapes muscles work normally in geriatric group. In the reflex decay test, reliable results were obtained at contralateral 500 Hz. Acoustic reflex measurements with low- and high-frequency band noise may also be used to assess middle ear functions.

Keywords: Acoustic reflex, audiology, geriatric assessment

Introduction

Acoustic reflex measurement is a form of measurement provided by the contraction of the stapedius muscle. The innervation of the stapes muscle is provided by the stapedial branch of the facial nerve (1, 2). The acoustic reflex develops in response to the acoustic stimulus that is 70-90 decibels (dB) over the threshold of hearing. When a sound stimulus of sufficient intensity comes to the ear, stapes muscle responses by contracting. Normal operation of the afferent and efferent reflex arcs is necessary for the formation of the acoustic reflex. In this way, the inner ear is protected from high intensity sounds. No matter which ear the stimulus comes from, acoustic reflex is always bilateral (2, 3).

There are many factors that reduce the effectiveness of the acoustic reflex and prevent its function. These factors are the thinning and calcification of the joints in cartilaginous structures between the middle ear bones. This situation leads to weakening in ossicles with age. In addition, with atrophy in the ear, degeneration is seen in the ligaments of the fibrous tissue and the muscle fibers of the middle ear (4).

Reflex decay test has been developed in order to diagnose tumor-induced pathologies involving and affecting the auditory nerve. This test is usually done by giving sound that is 10 dB over the contralateral acoustic-reflex threshold at 500 or 1000 hertz (Hz) for 10 seconds. Reflex decay test has sensitivity at a ratio of 86-98%. While the reflex decay is negative in normal or cochlear pathologies, it is observed as positive in retrocochlear pathologies (5-7).

The purpose of this study is to evaluate ipsilateral and contralateral acoustic reflexes that occur with age depending on the changes in the middle ear and to evaluate the reflex decay tests by using pure tone and noise stimuli in the geriatric group.

This study was presented at the 8th Cochlear Implantation Otology-Neurootology Audiology Congress, 12-15 November 2015, Samsun, Turkey.

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Methods

This study has been approved by the Clinical Research Ethics Committee of the Faculty of Medicine of Turgut Özal University (2015/14-04). Twenty-five elderly individuals between the ages of 65-84 years (mean 74.3+5.4) (17 males, 8 females) and 25 adults between the ages of 18-45 years (mean 30.4+4.2) (15 males, 10 females) were included in this study. Written informed consent was received from the patients participating in this study through face-to-face interview. The individuals with normal otoscopic findings were included in the study. Those having ear disorders such as ear infections, ototoxicity and history of otologic trauma that may cause hearing loss were excluded from the study.

Those whose pure-tone average of the hearing threshold (according to 500 Hz, 1000 Hz and 2000 Hz) is 25 dB were included in the study (high frequency losses were neglected up to 50 dB). There was a maximum of 5 dB difference between the hearing thresholds of air and bone conduction of those who were included in the study. The inner ear sensitivity (recruitment) of individuals of the geriatric group participating in the study was determined by uncomfortable loudness (UCL) testing. UCL values up to 100 dB were considered to be normal inner ear sensitivity.

Compatibility of high frequency hearing loss with the word discrimination scores (WDS) and negativity of reflex decay tests were sought for the exclusion of retrocochlear pathologies. After the ENT examination of patients, pure tone audiometry testing was performed with Interacoustics AC40 audiometer (Interacoustics Assens, Denmark), acoustic reflex and reflex decay tests with Interacoustics AZ26 tympanometry (Interacoustics Assens, Denmark). Pure tone hearing tests were done by using TDH-39 standard headphones and air conduction hearing thresholds were measured between 125-8000 Hz in a quiet cabin. Afterwards, immitansmetric measurements, ipsilateral and contralateral acoustic reflex and reflex decay measurements were made.

As to the acoustic reflex measurements, ipsilateral and contralateral acoustic reflexes of the individuals who were found to have normal (Type A) tympanogram findings in the result of immitansmetric measurements were checked in 500-4000 Hz range. Middle ear pressure was considered as normal in ±100 decapascal (daPA). Acoustic reflex measurements were made ipsilaterally and contralaterally and the levels of acoustic reflex threshold were determined. Afterwards, contralateral reflex decay test was done at 500 Hz. Reflex decay was evaluated as positive or negative by giving stimulus that was 10 dB over the acoustic reflex threshold for 10 seconds through supra-aural headphones.

Ipsilateral acoustic reflexes were assessed as yes/no through wideband (WB), low frequency band (Low Pass-LP) and high frequency band (High Pass-HP) noise. The acoustic reflex thresholds obtained through noise were compared between groups.

Statistical Package for Social Science (SPSS) 20.0 (IBM Corp.; Armonk, New York, USA) software was used for the statistical analyses. The basic statistical analyses of the obtained data were made, average values and standard deviation were calculated, and the analysis for the average values was obtained. In addition to t-tests, Kolmogorov-Smirnov (K-S test) was used in order to test whether or not the two groups were from the same probability distribution. The significance level (α) was compared with the p value that was found in the result of the test. The significance level (α) was accepted as 0.05 for this analysis.

Results

Right and left ear ipsilateral acoustic reflex thresholds of the geriatric and normal group are shown in Table 1 and the contralateral acoustic reflex thresholds are shown in Table 2.

No statistically significant difference was found in ipsilateral and contralateral acoustic reflex thresholds of the right and left ears of the geriatric and normal groups ($p>0.05$). However, 500 and 1000 Hz ipsilateral acoustic reflex measurements of the geriatric group were obtained approximately 6-8 dB lower. Although these results are not statistically significant, they have been accepted clinically significant. In the contralateral measurements, while there were clinically significant results (3-6 dB) in 500 Hz, no statistically significant results were found at other frequencies ($p>0.05$).

Reflex decay test was performed in geriatric and control groups at 10 dB over 500 Hz contralateral acoustic reflex thresholds for 10 seconds. Because the maximum sound output of tympanometer is 110 dB, less than +10 dB of sound was added in some patients. The minimum, maximum, average and standard deviation (SD) values of the right ear reflex decay thresholds are shown in Table 3.

No statistically significant difference was found between the right and left ear reflex decay thresholds of the geriatric and control groups ($p>0.05$). No statistically significant difference was found in in-group and inter-group comparisons of the right and left ear at 500 Hz contralateral reflex decay thresholds of the geriatric and control groups ($p>0.05$).

Ipsilateral acoustic reflex thresholds of the geriatric and control groups were obtained through right WB, LP and HP noise. Threshold values of the geriatric group that were obtained through the right ear noise are shown in Table 4.

Ipsilateral acoustic reflex thresholds of the geriatric and control groups were obtained through left ear WB, LP and HP noise. Thresholds values of the geriatric group that were obtained through left ear noise are shown in Table 5.

No statistically significant difference was found in the acoustic reflex measurements made through noise stimulus for the left and right ears of the geriatric and normal groups ($p>0.05$). In addition, while acoustic reflex was obtained through HP-band noise in five of the nine elderly patients in whom ipsilateral acoustic reflex could not be obtained through 2000 and 4000 Hz together, acoustic reflex was obtained through LP band noise in one of the six elderly patients in whom acoustic reflex could not be obtained through 500 and 1000 Hz together.

Discussion

Acoustic reflex is one of the most important tests of the audiological test battery. It is routinely used in audiological examination. Although it has no diagnostic value alone, it is one of the necessary tests to confirm the results of other tests performed. The acoustic reflex occurs in response to the high intensity sound given to the ear. The front of the base part of the stapes ossicle moves to the lateral and the posterior part moves to the medial; thus, the fixation is provided (8).

Information is provided about both the peripheral and central nervous system through acoustic reflex test. The airway transmission of the ear to which stimulus is given, cochlea, auditory nerve, cochlear nucleus, superior olivary complex and the facial nerve of the ear from which reflex will be obtained, nerve to stapedius, the stapes muscle and the middle ear must be normal for the formation of acoustic reflex (9, 10). This path that the stimulus follows is known as the acoustic reflex arc. When the acoustic reflex occurs, reduction is provided in the intensity of the sound that passes through the middle ear by the fixation of the base of stapes (11).

During the acoustic reflex test, it is considered that there isn't any problem in the outer and middle ear along with the movement of the stapes in the oval window. Therefore, obtaining the acoustic reflex is interpreted as there is no transmission problem (12). Besides, both afferent and efferent systems of the acoustic reflex arc are thought to be normal along with the obtaining of acoustic reflex. However, in some cases (acoustic neuroma, etc.), obtaining the acoustic reflex does not eliminate the possibility of retrocochlear pathology depending on the pressure on the auditory nerve. Acoustic reflex occurs as a result of a short stimulus. Thus, some retrocochlear pathologies may be missed out. Reflex decay test has an important place in order to eliminate this situation.

Reflex decay test is performed at an intensity level that is 10 dB over the contralateral 500 Hz or 1000 Hz acoustic reflex threshold for 10 seconds. Reflex decay test is obtained more positive in pathologies affecting the auditory nerve in comparison to the acoustic reflex test and gives more reliable results.

The results of the reflex decay test in our study show similarity in both geriatric group and adult group. Based on these results, the results of reflex decay test in the geriatric group are obtained reliably at contralateral 500 Hz. According to these results, the positive results of the reflex decay test in the geriatric group may indicate any pathological condition in the acoustic reflex arc. When these results that were obtained are examined through imaging techniques by an ENT specialist, early detection of retrocochlear pathologies and early start of the treatment can be enabled.

Table 1. Ipsilateral acoustic reflex threshold values of the geriatric and normal groups (mean±SD)

	Geriatric group				Control group			
	500 Hz	1000 Hz	2000 Hz	4000 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Right	94.20±10.17 dB	98.69±7.86 dB	99.58±8.36 dB	105.33±3.23 dB	106.00±3.57 dB	104.45±4.38 dB	98.69±7.36 dB	103.22±3.22 dB
Left	91.44±11.60 dB	93.52±11.22 dB	102.25±5.23 dB	104.56±4.68 dB	99.31±8.23 dB	103.81±4.44 dB	98.26±8.89 dB	103.54±4.16 dB

Hz: hertz; dB: decibel; Right: the right ear; Left: the left ear; SD: standard deviation

Table 2. Contralateral acoustic reflex threshold values of the right and left ears of the geriatric and normal groups (mean±SD)

	Geriatric group				Control group			
	500 Hz	1000 Hz	2000 Hz	4000 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Right	95.92±10.02 dB	96.24±7.08 dB	98.09±7.82 dB	102.82±4.40 dB	101.05±6.52 dB	97.00±3.79 dB	98.10±6.97 dB	103.5±4.40 dB
Left	94.12±7.56 dB	96.08±5.66 dB	102.32±4.69dB	104.32±3.41dB	97.18±7.56dB	98.43±2.48 dB	99.56±5.86 dB	101.05±7.52 dB

Hz: hertz; dB: decibel; Right: the right ear; Left: the left ear; SD: standard deviation

Table 3. The results of reflex decay of the right and left ear (contralateral 500 Hz)

	Geriatric group					Control group					
	n	Min. (dB)	Max. (dB)	Avg. (dB)	SD	n	Min. (dB)	Max. (dB)	Avg. (dB)	SD	p value
Right	25	95	110	104.43	2.48	25	90	110	105.98	2.23	>0.05
Left	25	95	110	103.33	3.01	25	95	110	104.58	1.19	

n: number of participants; Min: minimum; Max: maximum; Avg: average; SD: standard deviation; dB: decibel, Right: the right ear; Left: the left ear

Table 4. WB, HP, LP ipsilateral acoustic reflex results of the right ear of the geriatric group

	Geriatric group					Control group				
Stimulus	n	Min. (dB)	Max. (dB)	Avg. (dB)	SD	n	Min. (dB)	Max. (dB)	Avg. (dB)	SD
WB	24	85	100	99	8.09	25	80	110	98	9.25
LP	23	90	110	105	5.72	25	80	110	104	7.55
HP	21	90	110	104	6.80	23	80	110	104	7.91

n: number of participants; Min: minimum; Max: maximum; Avg: average; SD: standard deviation; dB: decibel, WB: wide band; LP: low pass; HP: high pass

Table 5. WB, HP, LP ipsilateral acoustic reflex results of the left ear of the geriatric group

	Geriatric group					Control group				
Stimulus	n	Min. (dB)	Max. (dB)	Avg. (dB)	SD	n	Min. (dB)	Max. (dB)	Avg. (dB)	SD
WB	23	90	105	101	5.90	25	85	110	101	5.22
LP	23	90	110	106	2.37	24	90	110	102	4.36
HP	20	90	110	103	5.20	24	90	110	106	3.06

n: number of participants; Min: minimum; Max: maximum; Avg: average; SD: standard deviation; dB: decibel, WB: wide band; LP: low pass; HP: high pass

One of the cases where the acoustic reflex test is used for diagnosis is facial paralysis. In the case of facial paralysis, a commentary can be made with regard to the detection of the location of the lesion and whether it is in the distal or proximal of the stapes innervation.

The presence of acoustic reflex is an important finding in sensorineural type of hearing losses that indicates a transmission component (superior semicircular canal dehissence) and in enlarged vestibular aqueduct syndrome (13,14). While acoustic reflex cannot be obtained in transmission problems that arise depending on the outer and middle ear, acoustic reflexes are obtained in these two cases and the detection of these two diseases that can be missed out can be done in an easy way. According to the findings obtained in our study, noise stimulus and acoustic reflex testing are diagnostically important in the cases in which sensorineural-type hearing losses showing transmission component are suspected. The observation of acoustic reflexes and performing the other tests (Vestibular Evoked Myogenic Potential-VEMP etc.) should be planned and included in the accurate diagnosis.

Brask (15) tried to show the protective effect of the acoustic reflex on the ear from the noise by using extratympanic manometer. In the disease and recovery periods, changes were tried to be created by giving additional +15 dB noise to the acoustic reflex thresholds of the patients with unilateral Bell's palsy. While no difference was seen in the hearing thresholds of the healthy ear, changes were observed in the hearing thresholds of the ear on the side with facial paralysis. It was concluded that less noise was transmitted to the healthy side with the effect of the acoustic reflex (15). Being used in the course of the treatment as well, the results of the acoustic reflex to be obtained in the case of Bell's palsy which may develop in geriatric and adult groups may be guiding for the ENT physician.

By using the acoustic reflex, it is possible to evaluate the integrity and functionality of the centers in the acoustic reflex arc. Anderson et al. (16) were the first to show the importance of the acoustic reflex in the differential diagnosis of retrocochlear pathology. In this study, it is reported that the contralateral acoustic reflex thresholds have abnormally increased in the case of acoustic tumors. In the same study, it has been shown that despite the failure to receive the acoustic reflex, the reflex decay test obtained in response to 10-second stimulus plays an important role in order to make a diagnosis for the tumoral pathologies involving or affecting the auditory nerve. It was reported that acoustic reflexes could not be obtained or would totally be normal in the presence of tumor. Therefore, it was also reported why the reflex decay test was necessary to be performed and that the Brainstem Auditory Evoked Responses (BAERs) were necessary to be included for the differential diagnosis (16). The reflex decay test performed with tympanometry device provides objective information more easily and faster. Although its sensitivity and specificity is poorer in comparison to BAER test, its being a complementary test will make it easier for the ENT specialist to plan the tests to be done and to determine the method to follow (17, 18).

There are several factors that depress the acoustic reflexes. These include neuromuscular diseases, certain drugs, chemicals (paints, thinners, solvents, etc.) and the use of ethyl alcohol. It was shown in 1980s that the acoustic reflex latency was observed in the pathologies of the auditory nerve and the amplitude of the acoustic reflex was a sensitive indicator of neuropathologies (19).

A number of age-related changes are observed in the auditory systems of the geriatric group. The eardrum, cartilages on the ossicular joint surface, middle ear muscles and fibrous tissue ligaments are the middle ear parts that are sensitive to a number of changes that occur depending on the age (20). In the absence of middle ear pathologies, the absence of acoustic reflex accompanied by normal or near normal hearing level suggests that retrocochlear pathology might exist (21).

However, this case does not always show retrocochlear pathology. Feeney and Keefe (22) reported in their study that more accurate results were obtained in the acoustic reflex measurements with broadband stimulus. Accordingly, the reflex thresholds were obtained at an 18 dB lower level with broadband stimulus. In our study, acoustic reflexes were obtained in more individuals with noise stimulus in comparison to pure tone stimulus. However, acoustic reflex thresholds obtained through noise were observed at higher levels compared to the ones obtained through pure tone stimulus. This situation was observed similarly both in adults and geriatric group.

Margolis and Popelka (23) found the average acoustic reflex thresholds as 99.70 dB at 250 Hz, 97.65 dB at 500 Hz, 91.05 dB at 1000 Hz, 90.25 dB at 2000 Hz, 91.50 dB at 4000 Hz, 77.20 dB in broadband and 97.20 dB with narrowband 500 Hz noise in individuals with normal hearing in their study. While the results obtained with pure tone and 500 Hz narrow band stimulus were consistent with the results of our study, broadband acoustic reflex thresholds were achieved at a lower intensity level. Broadband stimulus involves the range of 250 and 8000 Hz and the high thresholds in reflex measurements have been thought to be caused by this because more energy is needed for the stimulation with broadband (24).

Wilson and McBride (25) evaluated the acoustic reflex thresholds with different probe tone (220 Hz, 660 Hz, 1000 Hz) in their work and achieved similar results. The acoustic reflex thresholds that they obtained with 220 Hz probe tone were similar to the study we did and the acoustic reflex thresholds that they obtained using stimulus were observed in a lower level. The reason for this difference can be explained by that other studies were performed manually and our study was done automatically. Moreover, acoustic reflex and reflex decay tests are largely performed automatically in our clinics. Therefore, it is necessary to take our study as a reference for correct diagnostics.

Besides, the ipsilateral acoustic reflex thresholds were evaluated using noise stimulus (WB, LP and HP) in our study. It was accepted that WB covered the range between 500 and 4000 Hz, LP between 500 and 1000 Hz and HP between 2000 and 4000 Hz. Although the WB covered the range between 250 and 8000 Hz of the noise, it was taken as 500-4000 Hz in terms of standardization and the peak values were not evaluated. The acoustic reflex thresholds were observed to increase in the measurements made using noise stimulus. Similar results were shown in the study of Gelfand and Piper (26). At the same time, while the acoustic reflex was obtained with LP noise stimulus in one of the six ears in the geriatric group in which it couldn't be obtained with 500-1000 Hz pure tone, it was obtained with HP noise stimulus in five of nine ears in which it couldn't be obtained with 2000-4000 Hz pure tone. This situation shows that the presence of acoustic reflex is necessary and the use of WB, HP and LP stimuli would be useful in diagnostic terms in the case in which acoustic reflex cannot be obtained with pure sound.

In the assessment made by using pure tone stimulus, no difference was observed between the geriatric and control groups at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz. However, the ipsilateral and contralateral acoustic reflex thresholds were obtained approximately 5-12 dB lower in the geriatric group at 500 Hz and 1000 Hz. The presence of acoustic reflex and thresholds were obtained similarly at all frequencies between the geriatric and adult groups. Although it is not statistically significant, the acoustic reflex thresholds of the geriatric group at 500 and 1000 Hz were clinically obtained significantly lower than in the adult group. This situation is compatible with the tolerability problem seen in the geriatric group. Furthermore, reflex decay results were also obtained similarly between the two groups. Acoustic reflex test results are important in the differential diagnosis of peripheral and central auditory pathologies that occur with age. Failure to obtain acoustic reflex or the reflex thresholds over 103 dB requires the investigation of pathological conditions. Obtaining lower reflex thresholds indicates cochlear hair cell damage or the beginning of the damage.

In our study, the ipsilateral acoustic reflex thresholds were analyzed with WB, HP and LP noise stimuli. Acoustic reflex thresholds which could not be obtained with pure tone were observed with noise stimulus at some frequencies. Although this situation is advantageous, obtaining high levels of acoustic reflex thresholds through noise is a disadvantage because the noise stimulus at a high level of intensity can lead to a temporary change in threshold of the ear, albeit for a short time. Therefore, in the measurements of the acoustic reflex through noise stimulus, the ascending method should manually be used without elevating the intensity.

Conclusion

Acoustic reflexes are obtained in the geriatric group similar to those of the adult group. Thus, ipsilateral and contralateral acoustic reflexes and positive or negative reflex decay test are important in differential diagnosis. Using these tests not alone, but as an element of the audiological test battery increases the reliability of the tests. Furthermore, noise stimulus can also be used safely in the acoustic reflex measurements. While the noise stimulus gives beneficial diagnostic results, it is necessary to be performed carefully due to the possibility of damaging the ear because it is obtained at high levels of intensity.

In addition to this, acoustic reflex measurements are routinely performed in clinics, but reflex decay tests are not. Acoustic reflex (ipsilateral and the contralateral) and reflex decay tests should routinely be performed particularly in patients with the complaints of tinnitus, dizziness, etc. and in geriatric group. The detection of accompanying values in addition to the presence or lack of acoustic reflexes in these tests will provide important information for ENT physicians in the differential diagnosis of both cochlear and retrocochlear pathologies.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Turgut Özal University.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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