The Effect of high Acoustic Reflex-Sound on the Amplitude of transient Otoacoustic Emissions in Adults

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Abstract- Background and Objectives: As part of the inner ear, the normal human cochlea produces low-intensity sounds when it is stimulated by soft clicking sounds called Otoacoustic emissions (OAEs). However, these sounds are produced specifically by the cochlear outer hair cells as they vibrate, expand and contract, therefore producing inaudible sounds that echoes back into the middle ear. ***Aim:*** This study aims to examine the effect of high acoustic reflex sounds on the signal to noise ratio using transient otoacoustic emission in adults with normal hearing. The study also aims to reveal other medical status that may explain patients' complaints of symptoms such as vertigo and tinnitus. ***Method:*** A total of 40 of participants of both sexes aged between 18 and 22 years (mean: 22 years) were tested heir right ear side using a transient otoacoustic recording followed by acoustic reflex 750-2000Hz at the audiology and speech department at the audiology center at Zarqa university.

Results: Significant difference in the mean of signal to noise ration and the amplitudes were noticed after acoustic reflex testing. The maximum transient reduction of approximately 10 dB in the frequency range 750-2000 Hz after exposure to continuous steady high sound. The transient otoacoustic emission strength went back to base line before exposure after 30 minutes.
Conclusion: It can be concluded that using high continuous intensity sound has a significant correlation when reducing the transient evoked otoacoustic mission amplitude. We also emissions could not be detected in the ears of patients with cochlear hearing impairment (Kemp, et al, 1986; Wada et al. 1993; Zaho et al. 2000). This implies that the origin ofthe emissions is located in the cochlea.

Index Terms- *transient evoked otoacoustic emission amplitude, Ipsilateral acoustic reflex, signal to noise ratio, otologically normal adults*.

The normal cochlea does not only receive sound, it also produces low-intensity sounds called otoacoustic emissions (OAEs). These sounds are produced specifically by the cochlea and, most probably, by the cochlear outer hair cells as they expand and contract. The primary purpose of OAE tests is to determine cochlear status, specifically outer hair cell function. The information can be obtained from patients who are sleeping or even comatose because no behavioral response is required. There are four types of OAEs. Spontaneous otoacoustic emissions (SOAEs), transient otoacoustic emissions (TOAEs), distortion product otoacoustic emissions (DPOAEs), and sustained-frequency otoacoustic emissions (SFOAEs). DPOAEs are sounds emitted in response to two simultaneous tones of different frequencies (Atamimi et al. 2014). It has been confirmed that normal or nearly normal human ears produced the TEOAEs in response to short acoustic stimulus (Kemp, et al, 1986; Wada et al. 1993; Zaho et al. 2000). However, the emissions could not be detected in the ears of patients with cochlear hearing impairment (Kemp, et al, 1986; Wada et al. 1993; Zaho et al. 2000). This implies that the origin ofthe emissions is located in the cochlea. In our clinic in Jordan, acoustic reflex testing is routinely used for diagnostic purposes for differential diagnosis and in particular patients who complains of vertigo, facial palsy, and specific problems. Middle ear analyzer or tympanometer is used to perform this test. During testing in which the patient is instructed to be quite and to undergo some different intense sound above the threshold of hearing levels at different frequencies. The intense sound is about 105db SPL above the threshold of hearing at the tested frequency. After estimation of the acoustic reflex threshold the patient is instructed to hear a continuous intense sound, and the results displayed on the screen of the tympanometer. Many patients who underwent this test reported ear fullness, feeling of ear blockage, restlessness and transient tinnitus. Students who are trained at our audiology clinic at King Hussein medical Centre reported feeling of ear blockage and transient tinnitus after stopping the stimulus.

The purpose of the present study is to investigate the effect ofhigh acousticreflex sounds on the amplitude of the transient evoked otoacoustic emissionduct of otoacoustic emission that may explain comping sound of some patients. We select a group normal hearing adult of para- medical students from the Prince Aisha Bent Al Hussein College for medical allied sciences to perform the present study to rule out any other medical status that may explain the undesirable complaints. And audiological and speech students at Zarqa University and speech and hearing Centre atZarqa university

Methods

A total of 40 volunteers of both sexes aged between 18 and 22 years (mean: 22 years) were examined. Inclusion criteria were normal otoscopic and tympanoscopic findings, and pure tone threshold of <20dB for 750-2000 Hz frequency range. We examined one ear for each volunteer, i.e., 20 ears, underwent TEOAE recording followed by acoustic reflex testing for 500-2000Hz at the audiology department at King Hussein Medical Centre between September 2015 and August 2016the study was approved by the Royal Medical Services ethical committee. All volunteers were not paid or otherwise reimbursed.

Otoscopic examination were carried out on each ear of the

participants to ensure that no abnormalities which may interfere with the results, followed by hearing threshold determination using diagnostic audiometer type Interacoustic AC 40+, to ensure that all subjects have normal hearing threshold levels across the frequency range (500-2000 Hz), each subject demonstrated hearing threshold level less than 20 dB HL, then each ear underwent tympanometry to ensure no middle ear disorders or middle ear pressure variation that may affect the results. Each ear has middle ear pressure between +50 to -50 dapa after that each ear of the subject underwent TEOAE testing using biologic otoacoustic emission diagnostic protocol from 500- 2000 Hz. In the TEOAEs one stimuli using Scout biologic system. All measurements of the OAEs were repeated twice to ensure repeatability and accuracy, and then the ear which underwent the OEAEs immediately underwent acoustic reflex testing to determine the threshold of the reflex for the frequency range 500-2000Hz. For the acoustic reflex testing, estimation of acoustic reflex threshold levels was determined at each tested frequency and then the threshold of acoustic reflex level at each frequency was increased by 10 dB SPL. Measurements were ABD 10 FEMALErepeated twice to confirm and reliability and repeatability of the results. All measurements were carried in isolated sound proof test room at the Audiology Department at King Hussein Medical Centre from September.

III. Results

A statistical analysis involved the comparison between the mean TEOAE amplitudes (emission strength) for the ear tested of the 40 subjects before and after reflex detesting using ANOVA one way analysis at a significance level of $P < 0.05$.T-test value at P value < 0.05 was used to calculate the significance of comparison. Table I shows the mean acoustic reflex and reflex decay threshold levels of the right ear for 30 FEMALE malesand 10 females for the frequency 500-2000 Hz.

Table I: Mean acoustic reflex and Transient acoustic reflex threshold levels for 20 males and females

Frequency Hz	Mean Acoustic reflex threshold levels male	Mean Acoustic reflex threshold levels female
500	100	85
1000	110	95
2000	100	95

Table II shows the mean differences in the TEOAE amplitudes (emission strength) for the right ear of 20males before and after reflex testing for the frequency range 750 -2000 Hz.

Table II: Comparison of the transient of otoacoustic emission amplitude (emission strength) before and after reflex testing for the Rt ear of the 20 Males subjects

Emission strength (dB) Rt ear males before reflex testing	Emission strength (dB Rt ears (males) After reflex testing	Rt ear male emission strength (dB) differences before and after reflex testing
17	10.6	6.4
16.9	10.1	6.8
13.4	2.3	11.1

Table III shows the mean differences in the TEOAE amplitudes (emission strength) for the right ear of 20 females before and after reflex testing for the frequency range 750 Hz.

Table III: Comparison of the transient otoacoustic emission amplitude (emission strength) before and after reflex testing for the Rt ear of the 20females' subjects.

Emission strength (dB) Rt ear females) before reflex testing	Emission strength (dB) Rt ears females After reflex y testing	Rt ear female emission strength (dB) differences before and after reflex testing
20.3	14.2	6.1
22	12	10
15.7	6	9.7

It is apparent that the acoustic reflex threshold levels of male patients are slightly higher than the female patients; this may be attributed to sex anatomical differences.

It is apparent that the mean otoacoustic reflex otoacoustic emission amplitude for the Rt ear of 10 males' subjects are reduced by 6 dB at 2kHz, 6.8 dB at 1kHz and the maximum reduction was 11.1 at 750 Hz. It is apparent that the mean transient otoacoustic emission amplitude for the Rt ear of 10 females' subjects are reduced by 6.1 dB at 2kHz, 10 dB at 1kHz and the maximum reduction was 9.7 at 750 Hz. In both groups after 40 minutes of ending the test the emission strength went back to base line as before exposure. In addition to effect of high intensity transient evoked to acoustic emission

IV. DISCUSSION

Finding of the present study showed there is a significant reduction in the emission strength after exposure to the high intensity sound compared to the emission strength before the exposure. The differences in the emission strength were 6 dB at 2kHz, 6.8 dB at 1kHz and the maximum reduction was 11.1 at 750 Hz for the male group and were 6.1 dB at 2kHz, 10 dB at 1kHz and the maximum reduction was 9.7 at 750 Hz for the female group. In both groups there were significant differences apart from the effect of age and sex. This study assessed the effect of scientific diagnostic test used routinely in the clinics which differ from other studies that used environmental sounds. The findings of this study are in agreement with the findings of (Toro et al 2010, Prell et al. 2012) studies in that the effect of high intensity sound has a significant effect on the distortion product otoacoustic emission amplitude where significant reduction occurs post exposure to high intensity sounds compared to pre exposure.

An explanation of the reduction in the strength may be attributed to a decrease in stiffness of stereocilia secondary to contraction of rootlet structures, which are anchored to the cuticular plate of hair cells, intracellular changes within the hair cells including metabolic exhaustion and microvascular changes, edema of the auditory nerve endings, and degeneration of synapses within the cochlear nucleus (prell et al. 2012).

V. RECOMMENDATION

Further investigation to be carried out on a group of hearing-impaired patients to quantify the effect of the acoustic reflex testing on the transient evoked otoacoustic emission amplitude whether its reduction is temporary or permanent

I. CONCLUSION

There is a strong correlation between the high continuous intensity sound and the reduction in the transient evoked otoacoustic mission amplitude. The function of the outer hair cells (OHCs) is impaired after exposure to high intensity. Distortion product otoacoustic emissions (TEOAEs) are useful in examination of noise-induced level shifts. Reflex high intensity sounds may result in temporary reduction in the distortion product otoacoustic emission strength

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