Original Article

The effect of extracorporeal shock wave lithotripsy on the hearing

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Abstract

Objective: To investigate the effects of extracorporeal shockwave lithotripsy on hearing.

Methods: The study group consisted of 34 patients with urinary lithiasis on whom ESWL was applied in a single course. Patients with normal hearing levels were included in the study. Conventional audiometry and transient evoked otoacoustic emissions were recorded before the application of the procedure and thirty minutes afterwards.

Results: A total of 68 ears of 34 patients were evaluated. Of those, 15 (44.1%) patients were male and 19 (55.9%) were female. The average age was 31.47 ± 15.62 (range, 10-62 years). There was no statistically significant variation, according to the data obtained from the pure tone average threshold of the shockwave procedure on the otoacoustic emission test.

Conclusion: The results of the study indicate that the risk to the hearing of patients exposed to lithotripter noise is negligible and, therefore, ESWL is a safe procedure.

Keywords: Otoacoustic emission, ESWL, Hearing loss (JPMA 62: 10; 2012).

Introduction

The harmful noise level internationally recognised is 85 dB beyond which there can be hearing loss, which keeps accumulating over time. Constant exposure to noise at high levels causes certain changes, particularly in the organ of corti, which is located in the inner ear. Hair cells are also affected. It has been indicated that the most influenced cells are the outer hair cells.[1]

Otoacoustic emissions (OAEs) are active cochlea biomechanisms, which are incidents that require energy, and are caused by outer hair cells and illustrate the sensitivity and frequency selectivity of the cochlea. Today, there are two types of otoacoustic emissions; spontaneous otoacoustic emissions (SOAEs), and evoked otoacoustic emissions. The latter are classified amongst themselves according to the type of stimulus. There are three types of evoked otoacoustic emissions; Transient-evoked OAEs (TEOAE), Distortion product OAEs (DPOAE), and Stimulus Frequency OAEs (SFOAE). The most frequently used types in practice are TEOAE and DPOAE.[2,3]

Extracorporeal shockwave lithotripsy (ESWL) is frequently used in urology to break stones. The noise given off by the ESWL device during treatment may put hearing at risk.[4]

The purpose of the study was to investigate the effect the noise generated by the ESWL device has on the inner ear and hearing of patients receiving such a treatment.

Patients and Methods

This prospective cross sectional study was carried out in the Otolaryngology and Urology departments of Harran University between January and June 2010. The study group consisted of 34 patients with urinary lithiasis on whom ESWL was applied in one course, observing 68 of their ears.

In the Urology Department, abdominal radiographs (two sided) and kidney, ureter, bladder (KUB) urinary ultrasonographic evaluations were obtained for all patients to diagnose urinary lithiasis. ESWL was applied with a electrohydraulic type (ELMED Lithotripsy Systems, Multimed Classic) electrohydraulic lithotripter. Each ESWL session consisted of 3000 shock waves at frequencies between 60 and 120/min. In the Otolaryngology Department, all patients' otorhinolaryngologic examinations were performed. The cases with a history of chronic infection, ear surgery, diabetes mellitus, renal failure, otolaryngology abnormalities (micro-vascular free flap reconstruction, lip-palate abnormalities), ototoxic drug use, acoustic and head traumas were eliminated from the study. Their hearing levels, between 0.25 and 6 kHz, were evaluated through an audiologic test with an AC-40 Interacoustics Clinical Audiometer (Interacoustics, Eden Prairie, USA) and pure-tone averages (PTAs) were calculated at frequencies of 0.5, 1 and 2 kHz. The normal value was regarded as a hearing level < 25 dB in the tested frequencies. The TEOAE responses were recorded by using a laptop computer connected to an Otodynamics ILO 292 Echoport equipment (Otodynamics Ltd., Herts, UK) and EZ-Screen 2 software (eXibition Software, Dallas, TX). The recordings were performed in a soundproof booth. Only patients with normal hearing levels were included in the study.

All patients underwent ESWL only once. An average of 2500 shockwaves were applied to the patients during 30 minutes. Patients were audiologically assessed with conventional audiometry and TEOAE before ESWL, and 30 minutes after ESWL. Subsequently, subjective symptoms in patients such as tinnitus and pain in the ears were noted.

A TEOAE response was regarded as positive and acceptable for analysis if it satisfied all the following criteria: 1) mean amplitude of the cochlear response (dB sound pressure level [dB SPL]) being greater than the noise in the external canal; 2) reproducibility rate of the responses being greater than 50%; 3) rate of stimulus stability being greater than 75%; 4) stimulus amplitude being 75 dB SPL; 5) overall signal-to-noise of response (SNR) being 3 dB SPL; 6) rate of SNR at frequencies 1, 1.4, 2, 2.8, and 4 kHz being 3 dB SPL for at least two frequencies. The parameters of the TEOAE amplitudes, stimulus stability, stimulus intensity and reproducibility were recorded.

A written informed consent was obtained from patients directly, if they were adults (18 years) or from their legal guardians if they were underage. The study protocol was carried out in accordance with the Helsinki Declaration as revised in 1989 and it was approved by the Ethical Committee of the Harran University's Faculty of Medicine.

Statistical Package for Social Sciences (SPSS®, Chicago, Illinois, USA) Windows 11.5 programme was used for statistical analysis. Pre-ESWL and post-ESWL audiologic test findings of 68 ears were compared with paired sample t-test. A two-tailed p value of less than 0.05 was considered statistically significant.

Results

Our study examined 68 ears of 34 patients. Of the total, 15 (44.1%) were male, and 19 (55.9%) were female. The average age of the cases was 31.47±15.62 years (10-62). According to the results obtained, there was no significant change in the otoacoustic emission test caused by the average threshold value of the pure tone of the ESWL (Table). None of the patients suffered from tinnitus, pain in the ears, or hearing loss following ESWL.

In terms of ambient noise, measured using a Testo-815 noise level meter, it was 58 dB when the ESWL device

Table: A comparison between TEOAE and Average Threshold Value of Pure Tone, before and after ESWL.

		Before ESWL dB	After ESWL dB	P
Stimulus	Right Ear	81.15±2.81	81.08±3.02	0.680
	Left Ear	80.96±7.55	81.07±7.37	0.140
Amplitude (4.0 kHz)	Right Ear	8.32±3.90	8.16±4.22	0.279
	Left Ear	8.51±6.52	8.43±6.35	0.262
Stability	Right Ear	100.00	100.00	0.140
	Left Ear	100.00	100.00	0.824
Reproductivity	Right Ear	86.20±15.77	86.41±15.96	0.957
	Left Ear	81.11±19.89	81.82±20.34	0.824
Pure Tone Average (dB)	Right Ear	13.49±9.50	13.47±9.64	0.940
	Left Ear	11.96±5.26	12.08±5.08	0.424

The Stimulus, Amplitude (4.0 kHz), Stability and Reproductivity are presented as TEOAE parameters.
TEOAE, Transient-evoked Otoacoustic emissions; ESWL, Extracorporeal shockwave lithotripsy; dB, decibel.

was switched off, 84 dB at the patient's side, and 79 dB by personnel when the ESWL device was working.

Discussion

Exposure to noise at high levels causes certain changes in the inner ear, particularly, the organ of corti. It has been indicated that the most affected cells are the outer hair cells. At first, exposure to sound, the strength of hairs is affected which causes curvature disorders. However, resting stabilises this order and the belief is that this is the mechanism of temporary hearing loss. However, if exposure to noise continues, hairs get tangled and start to lose their stereocilia. Damaging effects occur between 3000-6000 Hz, and the longer the period of noise exposure, the more is the damage incurred. Loss of hearing increases with the pitch of the noise. Hearing protection programmes should be implemented at workplaces where the exposure to noise of 90 dB is 8 hours.[1,5,6]

Otoacoustic emissions are low-level noises that arise as a reflection of active processes in the cochlea and can be measured in the outer ear channel. Kemp first identified them in 1978. Outer hair cell movement creates a mechanical energy inside the cochlea. This energy passes through the middle ear via the oval window (vestibular window), the tympanic membrane, to the ear channel. An acoustic signal (otoacoustic emission) forms as the tympanic membrane vibrates and this signal is measured using a sensitive microphone. Otoacoustic emission measurements are a sensitive indicator in assessing peripheral hearing functions. It allows us to objectively monitor small changes in the cochlea, determine the cochlea component that is causing the loss of hearing and cannot be determined using other audiology methods. Implementation is fast, simple and easily tolerated by the patient. They are non-innovative, objective result-based tests. At the clinic, they are used to monitor loss of hearing due to noise.[7,8]

Extracorporeal shockwave lithotripsy is a treatment frequently used in urolithiasis. There are three types of ESWL devices used in clinical practice; electro-hydraulic, electromagnetic and piezoelectric. The ultrasonic (acoustic pulse) waves have instant and sharp character and a shock effect. During the process, a powerful sound that is created by the shockwaves is heard.[4,7]

Terlecki et al.[4] measured the level of noise created at different distances for five patients being treated with ESWL. The average noise level for patients was 89 dB; technicians, 84 dB; anaesthetists, 81 dB; and urologists, 79 dB. Patients were given 2500 shocks during 25 minutes. As the noise did not exceed the legal standard of 90 dB over 8 hours per day, no disorders were seen in the test subjects. In our study, the noise next to the technician and above the patient was lower. The ESWL device in our study created 2500 shocks over 30 minutes.

Muluk et al[7] conducted a study on 20 ears of 10 ESWL treatment patients; 9 patients were given 3000 shocks over 27 minutes, and one patient was treated for 50 minutes. TEOAE was applied to cases before ESWL and on the 1st and 15th day after ESWL. The TEOAE stimulus, stability and amplitude between 1.0-4.0 kHz were recorded for patients and the control group. No difference was determined between the values recorded before and after ESWL in conclusion of the study carried out between patients and the control group. In our study, no change was observed for average pure tone and TEOAE values, even though ESWL treatment was applied during the same day.

Several studies conducted on patients and staff by Naguib et al[9] and Dawson et al,[10] determined that temporary tinnitus and loss of hearing occurred after ESWL treatment, depending on the period and density of noise. It has been emphasized that this effect is due to the temporary disorder in outer hair cells. Virks et al[11] indicated that no loss of hearing or damage is caused by ESWL treatment, having conducted numerous studies on 30 patients.

After assessing the studies conducted, it is emphasised that patients with hearing in one ear should take care, even

though ESWL does not have damaging effects on hearing.[7,9,10] Therefore, patients should be questioned with regards to their hearing prior to ESWL; audiometry examination should be carried out if necessary.

Conclusion

The results of this study suggest that the effect the noise created during ESWL has on hearing can be disregarded and is safe in terms of hearing. However, it is good practice to monitor the patient's hearing during ESWL treatment.

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