DPOAE measurements in comparison to audiometric measurements in hemodialyzed patients

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ABSTRACT

Objective: To investigate the early detection of the damage of cochlear activity by using distortion product otoacoustic emissions (DPOAE) (DP-gram) comparing to the results of the impedance audiometry.

Methods: We examined 53 patients including 43 hemodialyzed patients, and 10 controls. First it was applied a tympanometry, and then in normal results we applied impedance audiometry and DPOAE (DP-gram).

Results: We found sensorineural hearing loss in 67% of audiometric results of the hemodialyzed patients and there was a decrease of the DPOAE amplitude in 77% of hemodialyzed patients. In the control group there was one patient (10%) with neurosensorial in high frequencies hearing loss in both measurements with audiometry and DPOAE.

Conclusions: There is a sensorineural hearing loss observed in most of the patients with chronic renal failure. DPOAE audiogram shows lower amplitudes than impedance audiometry and it can be used for the early detection of cochlear damage.

1. Introduction

Otoacoustic emissions are tests used to determine the hair cell function of the cochlea. So otoacoustic emission testing can be used as a tool to determine the presence or absence of cochlear function and analysis can be performed for individual cochlear frequency regions[1,2]. Another potential use of distortion product otoacoustic emissions (DPOAE) measurements might be to predict auditory response growth, such as growth of loudness. This application would be of interest clinically because one consequence of cochlear hearing loss may be an abnormal growth of loudness, sometimes referred to as loudness recruitment[3].

DPOAEs are sounds emitted in response to 2 simultaneous tones of different frequencies. Stimuli consist of 2 pure tones at 2 frequencies (f2 > f1) and two intensity levels (L1, L2)[4,5]. The relationship between L1–L2 and f1/f2 dictates the frequency response. DPOAEs allow great frequency specificity with a great reliability above 1000 Hz[6].

Hearing losses above 50 dB HL are not quantifiable using DPOAEs and their performance at frequencies below 1 kHz is limited, but their recording time is short[7].

Presence of hearing loss and estimation of type and degree is one of the most common methods used to investigate the effects of renal disease on the auditory system[8]. Degree of hearing loss may give an indication of the extent of damage to auditory function, whereas the type of hearing loss may distinguish between lesions in the outer and middle ear (conductive hearing loss) or the cochlea and the neural pathways (sensorineural hearing loss)[9]. According to these indicators, the reports to be reviewed in the following sections have also described auditory function in CRF with methods such as tympanometry, audiometry and otoacoustic emissions (distortion product OAEs, DPOAEs).

2. Materials and methods

We analyzed 53 patients (106 ears) including 43 subjects of different stages of renal failure disease undergoing hemodialysis treatment and 10 controls.

The criteria for case selection were: age 15–50 years[10], hearing impairment after the occurrence of renal failure, no history of noise exposure, no history of diabetes, no history of renal transplantation.

The criteria for healthy volunteers were: age 15–50 years, normal renal function tests, no history of noise exposure, no history of diabetes, no history of renal transplantation.
Renal failure was diagnosed by elevated level of blood urea and serum creatinine and associated oliguria. We did hearing evaluation by using tympanometry, impedance audiometry and DPOAE. We used a setting of 65/55 dB SPL L1/L2 in DPOAE examination.

3. Results

According to the results of the examinations done to the patients it showed that 29 patients out of 43 under hemodialysis treatment had sensorineural hearing loss in high frequencies in audiometric measurements and 33 of them had decreased DPOAE amplitudes (Figure 1).

In the control group only one patient had pure tone audiometry (PTA) threshold low in high frequencies and DPOAE gram according to the audiogram but lower values in >4000 Hz.

It was observed a higher incidence of hearing loss in stages three, four and five of renal failure with lower amplitudes in the DP-gram than PTA thresholds in the same frequencies (Figures 2 and 3).

Figure 1. DPOAE findings in CRF patients.

Figure 2. DPOAE and audiometric results of one of our patients.
4. Discussion

The survival of chronic renal failure patients is increased with the new hemodialysis treatments[11]. The impact of hearing loss on these patients in the social integration has to be addressed. So both primary prevention and early detection of hearing loss are important for providing management options.

As screening tools, DPOAEs are superior to PTA testing. DPOAE amplitude reduces significantly before behavioral threshold changes are noted at corresponding frequencies in PTA. Decreased emissions in the presence of normal behavioral hearing may indicate an underlying pathologic condition, which if continued might soon result in a significant hearing loss[12]. In this sense, the DP-grams may be predictive, foretelling a substantial threshold shift for a given frequency before a measurable sensitivity loss[13].

Our study demonstrated that DP-grams seem to be a more sensitive test than PTA for determining cochlear dysfunction.

DPOAEs have an extensive dynamic range regarding hearing loss and can be measured over a broader frequency range with more sensitive frequency specific response[14]. With their high sensitivity and excellent reliability, their objectivity makes them ideal for testing patients who cannot cooperate in a traditional examination of behavioral hearing. Their recording is easy for both technician and patient, and can be easily performed at the bedside. DPOAE audiograms provide a tool for a fast automated frequency-specific and quantitative evaluation of a mild or moderate hearing in follow-up diagnosis[15].

Therefore after a complete audiometric valuation it has to be established to monitor these patients periodically using DP-grams alone causing less inconvenience to these patients who are not feeling well.

Conflict of interest statement

The authors report no conflict of interest.

References


