



Contents lists available at ScienceDirect

Journal of Acute Disease

journal homepage: www.jadweb.org



Document heading doi: 10.1016/S2221-6189(14)60083-4

## Hearing evaluation in patients with chronic renal failure

Evis Bendo<sup>1\*</sup>, Margarita Resuli<sup>2</sup>, Spiros Metaxas<sup>3</sup><sup>1</sup>ENT Department, Mother Tereza University Hospital, Tirane, Albania<sup>2</sup>Internal Diseases Department, Mother Tereza University Hospital, Tirane, Albania<sup>3</sup>ENT Department, Papageorgiou Hospital, Thessaloniki, Greece

## ARTICLE INFO

*Article history:*

Received 8 January 2015

Received in revised form 12 January 2015

Accepted 14 January 2015

Available online 20 January 2015

*Keywords:*

Hearing evaluation

Chronic renal failure

Pure-tone audiometry

Distortion-product otoacoustic emission

## ABSTRACT

**Objective:** To evaluate hearing threshold and the severity of hearing loss at different frequencies in patients with chronic renal failure (CRF), and to analyze the role of duration of disease on hearing threshold in patients of CRF by measuring pure-tone audiometry (PTA) and distortion-product otoacoustic emission (DPOAE).

**Methods:** There were analysed 61 subjects (122 ears) from which 12 were patients starting hemodialysis (A), 24 subjects were patients undergoing hemodialysis over a year (B), 15 subjects were patients undergoing conservative treatment (C) and 10 controls (D). We did hearing evaluation by testing them using tympanometry, PTA and DPOAEs. Other parameters (blood pressure, body weight, blood chemistries) were also evaluated.

**Results:** It was found a severe high-frequency hearing loss among patients with CRF comparing to the control group. Duration on haemodialysis treatment does not seem to have a significant impact on the incidence of hearing loss, although the method of treatment may influence the impact of the disease on hearing. Hearing loss among patients with CRF seemed to deteriorate further a year after the first evaluation.

**Conclusions:** DPOAE raised the percentages of detection of SNHL indicating that it is a better technique than the conventional PTA for evaluation of hearing acuity.

### 1. Introduction

There are many similarities anatomical, physiological, pharmacological and pathological between the nephron and the stria vascularis of the cochlea and hearing loss has been reported in patients with renal failure. The gross anatomy of the kidney and cochlea differs greatly, although there are many similarities at the ultra structural level. Both of them contain epithelial structures in close contact with their vascular supply. Basement membrane is found closely opposed to capillary endothelium in both Bawmans capsule and proximal renal tubule of the kidney and also around the capillaries of the stria vascularis.

The incidence of the cochlear hearing loss in patients with chronic renal failure (CRF) exceeds that of an age and

sex matched normal population. Audiometric hearing loss may be defined as an average loss of greater than 20 dB for the frequencies 1, 2, 4, 6, 8 kHz<sup>[1]</sup>.

In the present study, we aimed to evaluate hearing threshold and the severity of hearing loss at different frequencies in patients with CRF, and to analyze the role of duration of disease on hearing threshold in patients of CRF by measuring pure-tone audiometry (PTA) and distortion-product otoacoustic emission (DPOAE). We excluded those patients with etiological factors known to predispose to hearing loss such as congenital hearing loss (Alport syndrome), middle ear disorders, noise induced hearing loss and cochlear ototoxicity.

### 2. Materials and methods

We analysed 61 patients (122 ears) from which 24

\*Corresponding author: Evis Bendo, ENT Department, Internal Diseases Department, Mother Tereza University Hospital, Tirane, Albania.

E-mail: drbendo@gmail.com

subjects were patients undergoing hemodialysis over 1 year, 12 subjects were patients starting hemodialysis treatment, 15 subjects were patients undergoing conservative treatment and 10 controls.

We did hearing evaluation every 3 months for a period of one year by using tympanometry, then audiometry and DPOAE was applied only for patients with normal middle ear condition and hearing threshold better than 30 dBHz.

DPOAEs reflect non-linear processes of hair cell motion and are generated by the active cochlear mechanisms responsible for enhancing basilar membrane vibration 'cochlear amplifier'.

Patients with history of otological diseases, ear trauma, noise exposure, diabetes mellitus or receiving ototoxic drugs were excluded. We selected patients who were relatively young (aged less than 50 years old) to avoid the possibility of the effect of early presbycusis on the results.

### 3. Results

#### 3.1. Observations

In the CRF patients group between the patients just starting hemodialysis, there were 5 patients out of 12 with sensorineural hearing loss (SNHL) especially in high frequencies, and in the group with the hemodialysed patients over a year there were 12 patients out of 24 with SNHL (Figure 1).

All the 17 patients of CRF with SNHL had moderately severe to severe degree of hearing loss. As the number of hemodialysis increased, the chances of developing SNHL

and degree also increased. There was a high incidence of SNHL even in patients with long standing CRF. In the group of patients undergoing conservative treatment, there were 6 patients out of 15 with SNHL. As the duration of CRF progresses, patients become more prone to develop hearing loss.

DPOAE raised the percentages of detection of SNHL indicating that it is a better technique than the conventional PTA for evaluation of hearing acuity.

In the study of control group of 10 healthy volunteers (selected from patients of ENT emergency visited for different problem than ears problem), only 1 case had SNHL which was moderate and of high frequency range.

All the healthy volunteers had serum creatinine, blood urea, serum electrolytes level within normal limits and the systolic blood pressure was <140 mmHg.

Patients with SNHL over 70 dB had significantly low sodium and higher potassium and chloride values. This showed the role of electrolytes in causing SNHL.

Serum creatinine indicated the extend of renal disease, but its levels were similarly raised in all cases of CRF with or without SNHL.

#### 3.2. Blood pressure

All patients of CRF had raised blood pressure >160 mmHg (systolic).

#### 3.3. Blood urea

All patients of CRF with SNHL had raised blood urea level, but this did not go progressively with the number of patients.

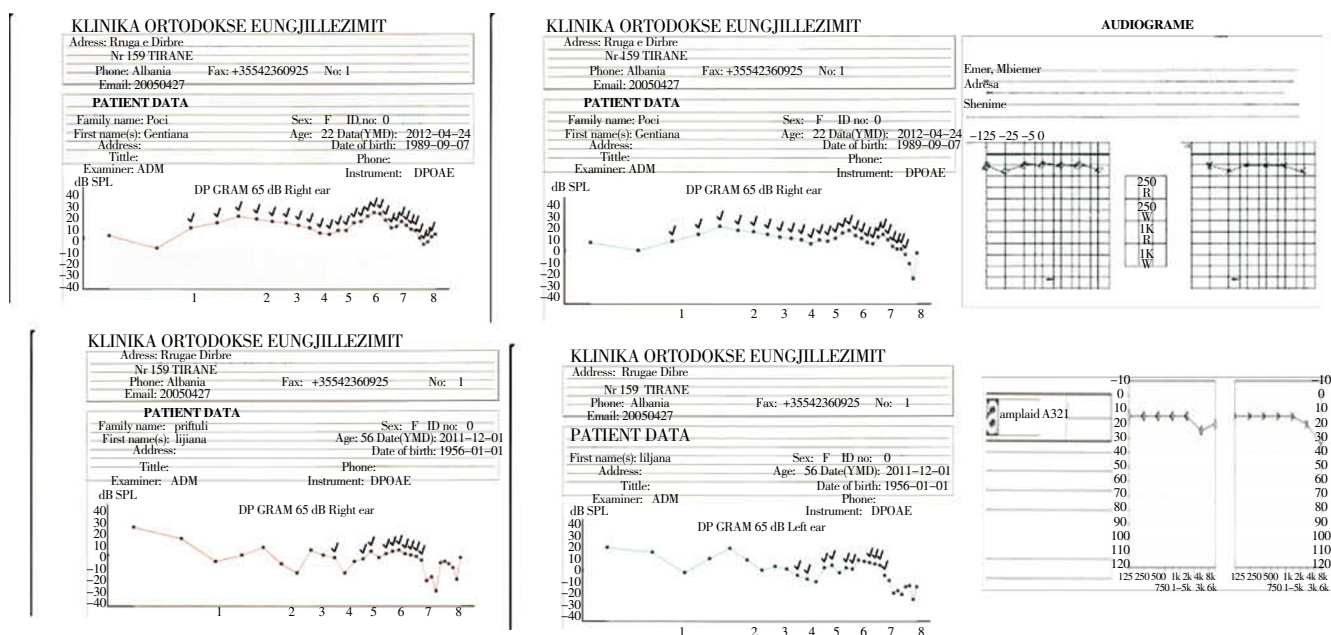


Figure 1. Patient undergoing hemodialysis less than 1 year.

#### 4. Discussion

The cochlea and kidney may have common antigenicity<sup>[2,3]</sup>, similar mechanism of the active transport of the fluid, electrolytes accomplished by the stria vascularis and glomerulus respectively<sup>[1,4]</sup>. These may be the reasons of the similar influence of the the genetic factors and similar effects of medication on both organs.

Several aetiological factors have been linked to hearing loss in renal failure<sup>[5,6]</sup> including the use of ototoxic medications, electrolyte disturbances, hypertension<sup>[7,8]</sup> and hemodialysis treatment<sup>[9–12]</sup>. Brookes suggested that vitamin D deficiency might be a contributing factor to hearing loss in renal failure<sup>[13]</sup>. Alder *et al.* found a significant reduction of Na<sup>+</sup>, K<sup>+</sup> activated ATPase in the inner ear of the uremic guinea pigs<sup>[14]</sup>.

From these observations the positive factor which may be a cause of hearing loss in CRF patients was long duration of the renal failure. The hearing loss on these patients is not of genetic origine. It happens even after exclusion of known risk factors such as noise exposure, ototoxic drugs, head injuries, old age, *etc.* The presence of additional factors accelerate the cause of hearing loss. The presence of electrolyte imbalance, hypertension, proteinuria, and haemodialysis are some of the factors which seems to have cumulative effect on deterioration of hearing in patients who were suffering with CRF.

All patients had SNHL of moderately severe to severe degree in high frequency range, which was bilateral and symmetrical. The incidence and degree of hearing loss increases with the number of haemodialysis. Patients with SNHL over 70 dB had significantly low sodium and higher potassium and chloride value. All patients who had SNHL had long duration of renal failure. All patients of SNHL had systolic blood pressure >160 mmHg. The increase level of serum creatinine and blood urea cannot predict the occurrence of hearing loss.

So it can be concluded from the study that patients suffering from long standing renal failure (long duration) had more chances of hearing loss than the healthy volunteers and there is cumulative effect of other risk factors such as haemodialysis, electrolyte imbalance, hypertension, proteinurea on SNHL in CRF patients. Hearing loss is becoming increasingly evident, as the patients tend to live longer because of improved quality of life of CRF patients. The raised blood urea level, serum creatinine level, and decrease kidney size does not predict the occurrence of SNHL.

DPOAE raised the percentages of detection of SNHL indicating that it is a better technique than the conventional pure-tone audiometry for evaluation of

hearing acuity.

#### Conflict of interest statement

The authors report no conflict of interest.

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