

# Hearing threshold in patients with chronic renal failure

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## ABSTRACT

**Objective:** To determine the pattern of hearing loss among patients with chronic renal failure (CRF).

**Methods:** This is a case control study carried out jointly by the Otorhinolaryngology and Nephrology Departments of the University College Hospital Ibadan, Nigeria between December 2004 and March 2006. Consecutive CRF patients who satisfied the inclusion criteria were recruited, the patients had not had hemodialysis prior to inception of the study. Parameters like age, gender, duration of illness and blood pressure were recorded and pure tone audiometry was carried out. The data was analyzed using the Statistical Package for Social Sciences.

**Result:** Thirty-three CRF patients and 28 healthy controls (34 males and 27 females) were used. The age range was 16-72 years, mean of 45.30 (SD 16.20). Sensorineural hearing loss was found in 67% of CRF and 32% of controls. The mean hearing threshold of CRF was 47.42 (SD 18.55) while the controls was 35 db, unpaired t-test (value -5.155) and Pearson correlation  $p=0.0008$ ,  $r=0.614$  showed the difference was significant. There was a correlation between duration of renal disease and hearing threshold  $p=0.00387$  ( $r=0.73$ ). There was no correlation between the hearing threshold and the diastolic blood pressure  $p=0.056$  dosage of diuretics  $p=0.155$  ( $r=0.12$ ) and creatinine level of the patients  $p=0.35$  ( $r=0.31$ ).

**Conclusion:** Sensorineural hearing loss is common among patients with CRF and related to the duration of renal disease, we recommend periodic audiological assessment incorporated in the care of these patients.

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The relationship between the kidney and the cochlear has been reported to include similarity in the anatomic architecture and shared antigenicity.<sup>1</sup> This is further supported by the observation of the sensorineural hearing loss (SNHL) in many of the congenital renal failure (RF) and the fact that many nephrotoxic drugs are also ototoxic.<sup>2,3</sup> Lengthening of the interpeak latencies in the auditory brain stem response, collapse of the endolymphatic space and deposits in the stria and vestibular apparatus have been documented in uremic patient.<sup>3,4</sup>

There had been various reports of isolated cases of sudden hearing loss in chronic renal patients, however, prevalence figure has been between 20-40%.<sup>2,4-7</sup> The etiopathogenetic mechanisms reported include loss of hair cells due to osmotic alteration, edema and atrophy of specialized auditory cells, endolymphatic space collapse; and in some, complications of hemodialysis have been hypothesized.<sup>3</sup>

We report herein our findings on the case control study of the hearing function of patients with chronic renal failure (CRF) using pure tone audiometry.

**Methods.** This is a case control study carried out jointly by the Otorhinolaryngology and Nephrology Departments of the University College Hospital Ibadan, Nigeria between December 2004 and March 2006. All CRF patients were recruited for pure tone audiometry (PTA) at admission. The PTA was carried out with a computer audiometer BA 20 Kamplex in the sound-proof (acoustic) booth in the ear nose and tongue clinic. Calibration: SO/DP 389-1983. The hearing was tested at the frequencies 500-8000 Hz for each ear separately. The average for the 4 frequencies 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz were recorded. An average of the threshold levels of >26 dB was considered as abnormal. A hearing loss of 26-40 dB was classified as mild, 41-55 dB as moderate, 56-70 dB as moderately severe, 71-90 dB as severe and >90 dB as profound.<sup>8</sup> A comparable number of age and gender matched control were selected among volunteers who were otherwise clinically healthy and had pure tone audiometry carried out and recorded.

The data was processed using the Statistical Package for the Social Sciences (SPSS Inc, Chicago, Illinois, USA).

The mean hearing acuity of CRF and controls were determined and unpaired t-test was used to find the significance of the difference. The inclusion criteria was consecutive CRF patients who had not had hemodialysis prior to inception of the study.

The exclusion criteria included CRF patients who have been previously treated with hemodialysis or have uremic encephalopathy, diabetes mellitus or severe illness precluding patients from responding at audiometry and those with history of chronic otitis media.

**Results.** Thirty-three CRF patients and 28 healthy controls were included in the study. This includes, 34 males and 27 females, age range was 16-72 years, mean of 45.30 (SD 16.20). The duration of illness was 3 months-10 years, mean 9.64 months (SD 7.62). The diastolic blood pressure was between 90 and 250 mmHg, mean 113.64 (SD 21.33). The patients were on daily dose of diuretics between 40 mg and 200 mg; mean 102.42 (SD 66.29).

Hearing loss was found in 22/33 (67%) of CRF and 9/28 (32%) of controls. The degree was mild in 7 (21%), moderate in 4 (12%), moderately severe in 5 (15%), severe in 4 (12%) and profound in 2 (6%).

The hearing threshold of CRF was between 15 and 60 db, mean 47.42 (SD 18.55) while the controls were between 10 db and 70 db with a mean of 35 db (Table 1).

There was a significant difference between the mean hearing threshold of subjects and controls, student t-test (value -5.155). The Pearson correlation  $p=0.0008$  ( $r=0.614$ ) was also significant. There was correlation between duration of illness and hearing threshold,  $p=0.00387$  ( $r=0.730$ ).

There was no correlation between the hearing threshold and the diastolic blood pressure  $p=0.056$  ( $r=0.16$ ), dosage of diuretics  $p=-0.155$  ( $r=0.12$ ) and creatinine level of the patients  $p=0.35$  ( $r=0.310$ ).

**Discussion.** The high prevalence of sensorineural hearing loss among CRF patients in this study has also confirmed the susceptibility of the auditory apparatus in this condition. This is similar to other workers which

report it between 20 and 87%.<sup>1-5</sup> The etiopathogenesis is still not clear. The hypotheses include similarity in antigens of kidneys and cochlea, endolymphatic edema resulting from disturbance of water and electrolyte in uremia and ototoxicity from diuretic drugs, which are often used in treatment.<sup>1-7</sup> However, positive correlation between hearing loss and prolonged duration of illness observed in this study may suggest an insidious destruction of the cochlear attributable to the uremic process. The gradual course of the hearing loss may not make the disability arising from it noticeable in the early course of the disease. This is further evidenced by the preponderance of mild to moderate degree, which accounted for approximately 50% of the cases and the fact that compensatory mechanisms come into play. Similar findings were reported by Gatland et al<sup>9</sup> and Kusakari et al.<sup>10</sup> Gatland et al<sup>9</sup> reported a prevalence of sensorineural hearing loss, measured by pure tone audiometry, in 66 patients with chronic renal failure and threshold changes following hemodialysis were measured in 31 patients. The incidence of hearing loss was 41% in the low, 15% in the middle and 53% in the high frequency ranges respectively. No correlations with weight changes, hematocrit, metabolic bone disease or ototoxic drug history were found. Lam and Ozturan<sup>11</sup> studied 15 subjects and 10 controls using pure-tone audiometry (PTA) and distortion-product otoacoustic

**Table 2 -** Age and gender matching of tests and controls and etiology of chronic renal failure.

Variable	Test (N=33)	Control (N=28)
Age	16 - 72 (mean = 45.9)	21 - 69 (mean = 44.7)
Gender	Female = 14 Male = 19	Female = 13 Male = 15
Creatinine clearance	2.5 - 15 ml/min	
Etiology (N=33)	Hypertension = 19 Chronic glomerulonephritis = 9 Nephrotoxicity = 4 Idiopathic = 1	

**Table 1 -** Degree of hearing loss in chronic renal failure and controls.

Pure tone average	Normal (0-25 dB)	Mild (26-40 dB)	Moderate (41-55 dB)	Moderate-severe (56-70 dB)	Severe (71-90 dB)	Profound (>90 dB)
Subject (N=33)	11 (33)	7 (21)	4 (12)	5 (15)	4 (12)	2 (6)
Control (N=28)	19 (68)	4 (14)	2 (7)	2 (7)	1 (3.7)	0
P-value	0.006	0.23	0.357	0.005	0.05	Not measurable

emissions. All 15 subjects revealed significantly poorer hearing in the higher frequencies, compared to that of the controls. Hence, they concluded that the sensorineural hearing loss in these patients may be attributed to the preexisting renal disease.

Nikolopoulos et al<sup>12</sup> reported sensorineural hearing loss (mainly high-frequency) of unknown cause in 14 patients (30.4%). Hearing loss was not influenced by the various hematological, biochemical and clinical parameters (type of renal disease, blood pressure, history of ototoxic drugs administration).

Bergstrom et al<sup>13</sup> reported hearing loss in 91 of 224 CRF patients. A study of temporal bone from one of these patients revealed fibrous tissue in the perilymphatic spaces, while others showed degeneration of the organ of corti and loss of hair cells of the organ of corti. They suggested that strial deposits were calcific and possibly resulted from the deranged calcium-phosphorus metabolism.

Although, our study did not find any correlation with the dosage of diuretic drugs, this class of drugs commonly used by all the patients must have contributed to the hearing loss. Nadol<sup>14</sup> and others,<sup>15,16</sup> reported that CRF patients are particularly predisposed to developing sensorineural hearing loss if administered loop diuretics such as Frusemide and Ethacrynic acid cause. The hearing loss is reported to begin between 5 days to several months after commencement of the agents.

The variation in the previous reports may be due to the differences in the audiologic modality for investigation and the criteria for defining hearing loss. In our study, a pure tone audiometer was used similar to other investigators,<sup>9,10</sup> however, more sensitive modalities such as otoacoustic emission, auditory brainstem response could have improved hearing loss thus, raising the prevalence figure in this study.

We conclude that sensorineural hearing loss is common among patients with CRF, which may be related to prolonged duration of the disease, therefore incorporation of the care of auditory function in the rehabilitation of such patients is advocated.

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