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Association Between Sensorineural Hearing Loss and Various Stages of Chronic Kidney Disease

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Abstract

Objectives To compare the proportion of sensorineural hearing impairment (SHI) among patients of chronic kidney disease (CKD) stages 3&4 with CKD stage 5.

Materials and Methods This is a cross-sectional study of 30 patients with CKD stages 3&4 and 30 patients in stage 5. All patients had an audiological evaluation with pure tone audiometry.

Results Our study had 49 males (82%) and 11 females (18%), with the age ranging from 20 to 60 years (mean: 45.13 years). The mean SHI values in stage 3&4 were 28.44 dB and in CKD stage 5 was 31.22 dB. In the right ear, the mean hearing loss in stage 3, stage 4, and stage 5 was 28.17 dB, 28.67 dB, and 31.84 dB, respectively. In the left ear, the mean SHI values in stage 3, stage 4, and stage 5 were 27.05 dB, 31.89 dB, and 30.61 dB, respectively.

The mean SHI in stage 3&4 for age group 20 to 30 years was 13.66 dB, for 31 to 40 years was 26.33 dB, for 41 to 50 years was 35.18 dB, for 51 to 60 years was 37.12 dB. The mean SHI in stage 5 for the age group of 20 to 30 years was 16.48 dB, for 31 to 40 years was 28.29 dB, for 41 to 50 years was 31.82 dB, for 51 to 60 years was 34.35 dB. There was a significant correlation between hearing loss and CKD with respect to age ($p < 0.001$). The duration of renal illness and associated comorbidities was not a significant contributor to hearing loss in our study ($p > 0.05$).

Conclusion As per our study, with progression in the stage of chronic kidney disease, the hearing loss also increased indicating a possible link between the two. We also noted that the hearing loss increased with the increasing age.

Keywords
- chronic kidney disease
- pure tone audiometry
- sensorineural hearing impairment

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Introduction

Sensorineural hearing impairment (SHI) has been reported in chronic renal failure (CRF) patients with a prevalence of 20 to 40%.[1] The etiopathogenic mechanisms reported include osmotic alterations resulting in the loss of hair cells, collapse of the endolymphatic space, edema, and atrophy of specialized auditory cells. Complications of hemodialysis are also known to cause SHI.[2,3]

Familial kidney disease such as hypoparathyroidism, deafness, and renal dysplasia (HDR) syndrome, brachio-oto-renal syndrome, Fabry disease, and mitochondrial myopathy, encephalopathy, lactic acidosis, and stroke (MELAS) syndrome are some of the other rare conditions or syndromes in which hearing loss is closely linked to chronic kidney disease (CKD).[4–7]

Certain anatomic similarities at an ultra-structural level and evidence for similar antigenicity of the cochlea and kidneys may explain the correlation between CKD and SHI. Also, multiple shared risk factors for CKD and SHI including age, diabetes, hypertension, and drugs that are both ototoxic and nephrotoxic may again explain the correlation between the two conditions. Moreover, in patients with established CKD, the use of ototoxic medications, hypertension, diabetes, electrolyte disturbances, and hemodialysis are known to cause SHI.[2,3]

The aim of study is to detect the presence and assess the degree of sensorineural hearing loss in patients with stage 3&4 chronic kidney disease and to compare the same in patients with stage 5 chronic kidney disease, using pure tone audiometry.

Materials and Methods

This was a cross-sectional, observational study done on patients who attended the department of ENT and nephrology. Thirty patients suffering from CKD stages 3&4 and 30 patients suffering from CKD stage 5 were enrolled in the study.

Inclusion criteria: chronic renal failure patients in CKD stages 3&4 and CKD stage 5 in the age group of 20 to 60 years.

Exclusion criteria:

- Patients having uremic encephalopathy or severe illness or unresponsive patients.
- Patients with a history of chronic otitis media, tympanosclerosis, and otosclerosis.
- Patients younger than 20 years of age or more than 60 years of age.
- Patients suffering from any malignancy.

The participants were staged according to the 2013 KDIGO staging criteria for CKD (►**Table 1**).[8]

Study analysis: Quantitative data were summarized as mean and standard deviation. The tests of significance were done using the chi-square test.

Method: All eligible patients who met the inclusion criteria were enrolled and informed consent for participation was taken. Baseline evaluation was done including history, demographic characteristics such as age, sex, and otoscopic examination. Pure tone audiometry (PTA) was done and the hearing acuity was measured in dB at frequencies ranging from 250 to 8000 Hz. The average for the four frequencies 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz was taken as the hearing threshold of that ear. The participants were grouped based on hearing acuity as mild, moderate, moderately severe, severe, and profound hearing loss as per the World Health Organization (WHO) classification of hearing loss.[5] PTA was performed by qualified audiologists in sound-treated booths using standard TDH-50 P, B 17 headphones, and Interacoustics AAA22 audiometer calibrated regularly to the All India Institute of Speech and Hearing (AIISH) standards.

Table 1 The 2013 KDIGO staging criteria for chronic kidney disease

Stage	Glomerular filtration rate, mL/min per 1.73 m^2
0	>90
1	90
2	60–89
3	30–59
4	15–29
5	<15

All patients were subjected to various blood tests including hemoglobin, hematocrit, blood urea, serum creatinine, and blood urea nitrogen. On the basis of the findings of biochemical investigations and Glomerular Filtration Rate (GFR) calculated by Cockcroft-Gault formula (►**Fig. 1**), participants were grouped under the various stages of CKD.

Statistical Methods: Descriptive statistical analysis was performed in the present study. Results on continuous measurements are presented as mean ± SD (min–max) and results on categorical measurements are presented as number (%). Chi-square test was used to compare the differences in proportions. Significance was assessed at a 5% level of significance.

Statistical software: The statistical software SPSS 18.0 was used for the analysis of the data and Microsoft Word and Excel were used to generate graphs and tables.

Results

Our study had 49 men (82%) and 11 women (18%) with the age ranging from 20 to 60 years (mean: 45.13 years). The mean SHI in stages 3&4 CKD was 28.44 dB and in CKD stage 5 was 31.22 dB. In the right ear, the mean hearing loss values in CKD 3, CKD 4, and CKD 5 were 28.17 dB, 28.67 dB, and 31.84 dB, respectively. In the left ear, the mean SHI values in CKD 3, CKD 4, CKD 5 were 27.05 dB, 31.89 dB, and 30.61 dB, respectively.

$$eC_{Cr} = \frac{(140 - \text{Age}) \times \text{Mass (in kilograms)} \times [0.85 \; if \; Female]}{72 \times \text{Serum Creatinine (in mg/dL)}}$$

Fig. 1 Cockcroft–Gault formula for calculation of glomerular filtration rate.

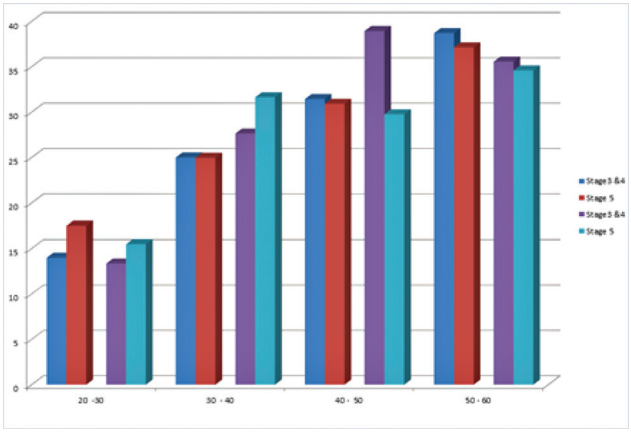

Fig. 2 Age-wise distribution of hearing loss in CKD.

Next, the participants were divided into four groups based on their age (20–30, 31–40, 41–50, and 51–60 years), and the mean SHI was calculated in each age group with respect to their stage of CKD (►**Fig. 2**). The mean SHI in CKD 3&4 for age group 20 to 30 years was 13.66 dB, for 31 to 40 years was 26.33 dB, for 41 to 50 years was 35.18 dB, and for 51 to 60 years was 37.12 dB. The mean SHI in CKD 5 for the age group of 20 to 30 years was 16.48 dB, for 31 to 40 years was 28.29 dB, for 41 to 50 years was 31.82 dB, for 51 to 60 years was 34.35 dB.

In the right ear, the mean SHI in CKD 3&4 for the age group of 20 to 30 years was 13.988 dB, for 31 to 40 years was 25.00 dB, for 41 to 50 years was 31.433 dB, for 51 to 60 years was 38.0 dB. The mean SHI in CKD5 for the right ear for the age group of 20 to 30 years was 17.5 dB, for 31 to 40 years was 24.967 dB, for 41 to 50 years was 33.914 dB, and for 51 to 60 years was 37.131dB. There was a significant correlation between hearing loss and the stage of CKD with respect to age ($p < 0.001$). Similarly, there was a significant correlation between hearing loss and the stage of CKD with respect to age ($p = 0.05$) in the left ear.

Next, the participants were divided into five subgroups based on risk factors (nil, hypertension, diabetes, hypertension with diabetes, others), and the mean SHI was calculated in each group with respect to their stage of CKD (►**Fig. 3**). The mean SHI of participants in CKD 3&4 without any co-morbidities was 18.56, with hypertension was 33.23, with diabetes was 27.73, with hypertension with diabetes was 34.93, and with other comorbidities was 13.82 dB. The results were not statistically significant in both groups. The mean SHI of participants in CKD 5 without any co-morbidities was 15, with hypertension was 30.6, with diabetes was 24.65, with hypertension with diabetes was 34.8, and with other comorbidities was 24.15dB. The results were not statistically significant in both groups.

Patients were divided into three subgroups based on the duration of illness (less than 1 year, 1–2 years, more than 2 years) and the mean SHL was calculated in each age group with respect to their stage of CKD. The results are shown in ►**Fig. 4**. The mean SHI of participants in CKD 3&4 with < 1 year of comorbidity was 20.89, with 1–2 years of comorbidity was 37.22, and > 2 years was 36.09. The mean SHI of participants in CKD 5 with < 1 year of comorbidity was 28.26, with 1–2 years of comorbidity was 39.55, and > 2 years was 34.89. The results were not statistically significant in both groups.

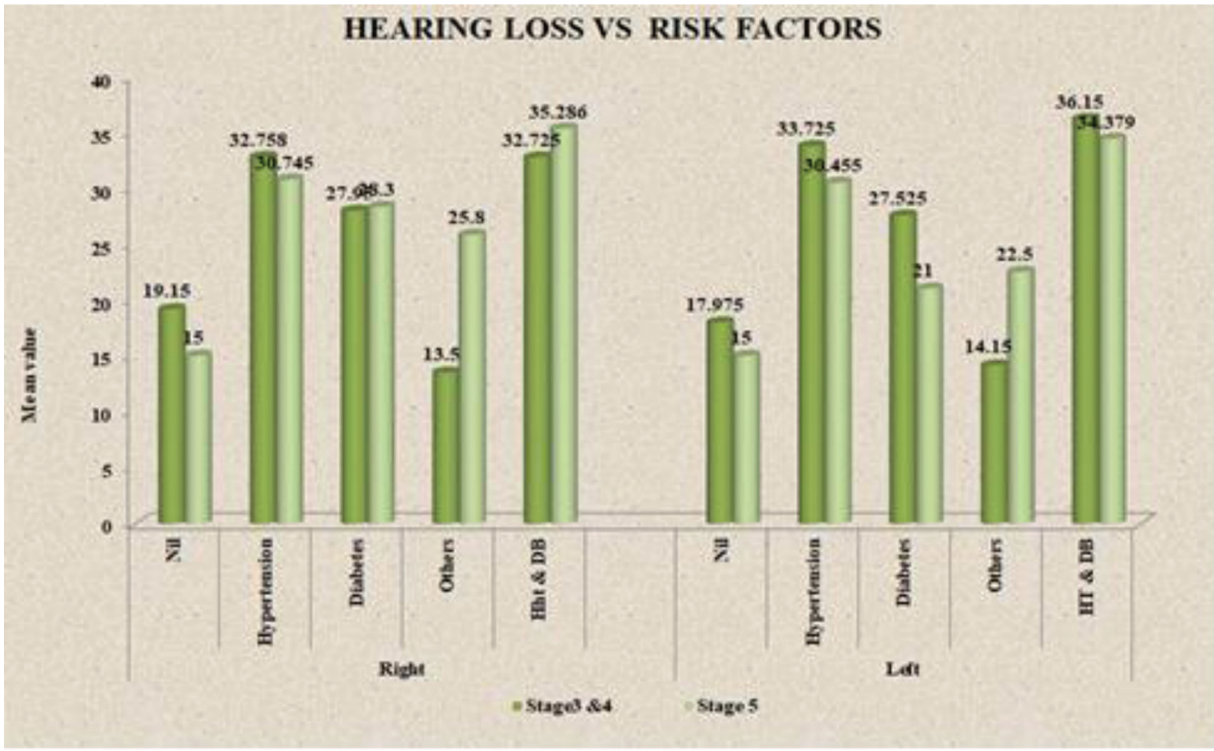

Fig. 3 Hearing loss versus risk factors.

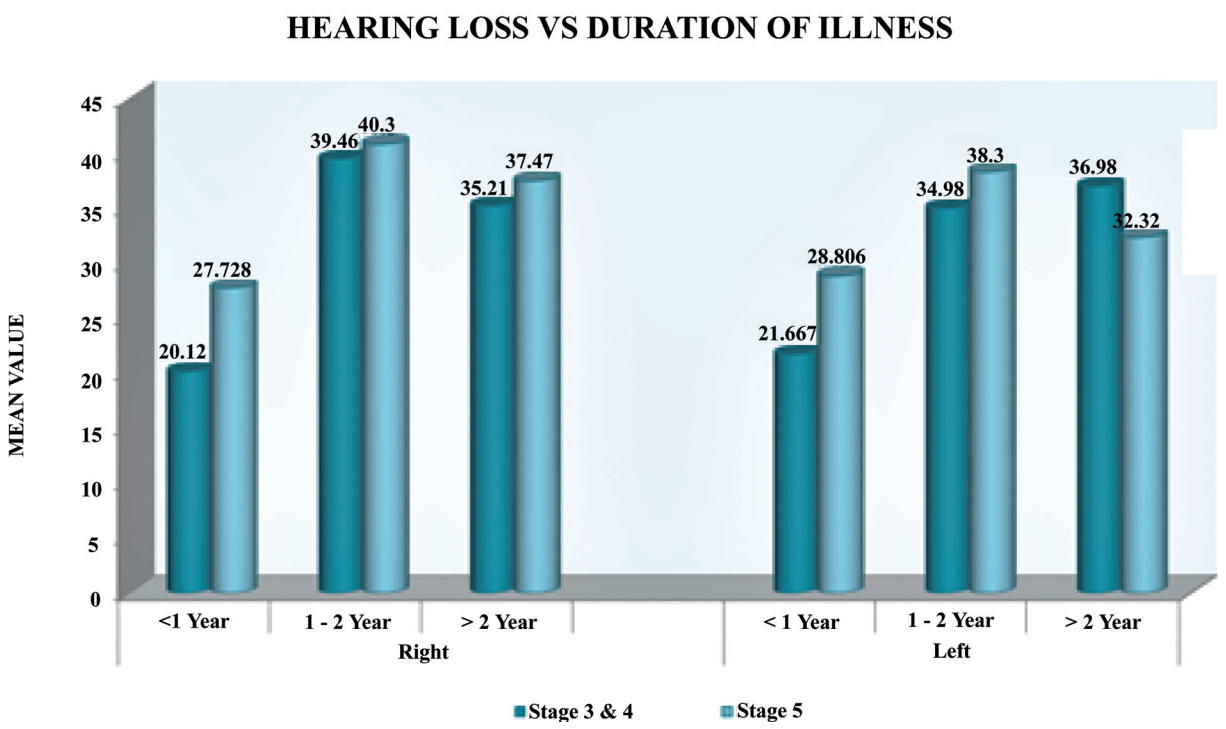

Fig. 4 Hearing loss versus duration of illness.

Discussion

Chronic kidney disease (CKD) has been associated with mainly SHL at least since 1927 when Alport first described it. Familial kidney diseases such as HDR syndrome, brachio-oto-renal syndrome, Fabry disease, and MELAS syndrome are some of the other rare conditions or syndromes in which hearing loss is closely linked to CKD.[4–7] Bergstrom et al reported hearing loss in 40% of CRF patients on hemodialysis and reported that 47% of 151 pediatric end-stage renal patients had hearing loss.[9] Kusakari et al studied inner ear function in 229 patients on chronic hemodialysis and reported that 60% had hearing loss, 36% had vestibular dysfunction, and 26% had a combination of both.[10] Zeigelboim et al found a more severe high-frequency hearing loss in the group with CRF and also reported that hearing loss among patients with CRF seemed to deteriorate further a year after the first evaluation.[11]

Rakesh et al showed 5 out of 17 patients in the age group of 15 to 30 years had SNHL, 6 out of 24 in the age group of 31 to 45 years had SNHL, 3 out of 9 in the age group of 46 to 60 years had SNHL.[12] In our study in CKD 3&4, for the right ear in the age group of 20 to 30 years and 31 to 40 years, the hearing was normal. In 41 to 50 years and 51 to 60 years, mild SNHL was noted. In CKD 5 in the right ear, age group of 20 to 30 years and 31 to 40 years, the hearing was normal, for 41 to 50 years and 51 to 60 years, mild SNHL was noted. Similar findings were noted in the left ear for both groups.

Jishana et al, in their 120 CKD patients surveyed, reported that 91 had hypertension (75.8%), 27 had diabetes mellitus (22.5%),13 had no risk factors (10.8%), and the SNHL in hypertension was seen in 69 (76%), in 6 (22%) in diabetes mellitus, and in 2 (16%) in no-risk patients.[13] In our study, of the 60 CKD patients surveyed, 43 had hypertension (71.6%), 28 had diabetes mellitus (46.6%), 6 had no risk factors (10%), and the SNHL in CKD participants with hypertension was seen in 37 (86%), in diabetes mellitus was 7 (25%), and in no-risk patients was 2 (33.3%)

In our study, the mean hearing loss in CKD 3&4 for no-risk participants was 18.7 db (normal), with hypertension was 35.7 db (mild SNHL), with diabetes was 27.73 db (mild SNHL), with hypertension + diabetes was 34.45 db (mild SNHL). In CKD 5, for no-risk participants, it was 15.00 db (normal), with hypertension was 30.2 db (mild SNHL), with diabetes was 24.6 db (mild SNHL), with hypertension + diabetes was 34.8 db (mild SNHL). Reddy et al in his study stated that for 4000 Hz hearing loss, 30% had a duration of illness of < 5 years and 45% had a duration of illness of > 5 years, for 8000 Hz hearing loss, 32% had a duration of illness of < 5 years and 78% had a duration of illness of > 5 years.[14] In our study, in CKD 3&4, the mean SNHL in the duration of illness of less than 1 year was 20.8 db, for 1 to 2 years was 37.22 (mild), for more than 2 years was 36.05 dB (mild). The mean SHL in the duration of illness of less than 1 year in CKD 5 was 28.2 dB (mild), for 1 to 2 years was 39.5 db (moderate), for more than 2 years was 34.8 dB (mild).

Rahman et al showed the relationship between CKD and sensorineural hearing impairment and the prevalence of hearing loss in CKD patients was as follows: stage III, 6.6%; stage IV, 33.3%; and stage V, 60%. In our study, the mean SNHL in CKD 3 was 27.61 db (mild), for CKD 4 was 30.28 db (mild), for CKD 5 was 31.22 db (mild).[15]

Conclusion

As the CKD progresses to a higher stage, the amount of SHI also increases, indicating a possible link between various stages of kidney disease and hearing loss. A significant correlation was noted between hearing loss and the stage of CKD with respect to age. The presence of comorbidities in patients with chronic kidney disease increases the risk of sensorineural hearing loss. This could help to understand the cause and modify the care of people with various stages of CKD.

Conflict of Interest
None declared.

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