



## STUDY OF PREVALANCE AND PATTERN OF SENSERINEURAL HEARING IMPAIRMENT IN STAGE 5 CHRONIC KIDNEY DISEASE PATIENTS ON HAEMODIALYSIS- AT A TERTIARY HEALTH CARE SETUP IN INDIA.

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Conflicts of Interest: Nil

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### Abstract:

**Background:** In patients with established CKD, multiple risk factors have been hypothesized to cause sensorineural hearing loss. There is high rise in the prevalence of CKD in India due to rise in conditions such as diabetes and hypertension.

**Aim of the study:** To identify the pattern of sensorineural hearing loss (SNHL) in stage 5 CKD patients on haemodialysis and to study the association between haemodialysis and degree of hearing changes.

### Study Design

Case control, observational, analytical study.

**Method:** In case control study 500 stage-5 CKD on haemodialysis patients and 500 age and gender-matched healthy individuals were included in this study over the period of 3 years. All patients were aged 18 to 50 years to exclude presence of presbycusis. After base line investigations, they were subjected for all cases and controls were subjected otoscopic examination and hearing assessment using standard pure tone audiometry. Descriptive statistical analysis has been carried out in this study.

**Result:** In CKD group, 96.5 % patients (5 patients had natural death) suffered from hearing loss and 3.5 % (17) patients had normal hearing. In control group, 31.2% suffered from SN hearing loss and 68.2 % (343) have no hearing loss. Among the Stage 5 CKD group, 11.9% had mild SN hearing loss, 14.2% had moderate SNHL (sensori-neural hearing loss), 14.8 % (71 patients) had moderately severe SNHL, 25.7% had severe SNHL, and 33.2% had profound SNHL. In the control group, 9% had mild SNHL, 7.6% had moderate SNHL, 7.1% had moderately severe SNHL, 5.4% had severe SNHL and 2.2% had profound SNHL. Deterioration of hearing acuity occurred in 62% of the patients at the end of follow-up and 12.4% of the participants showed improvement in hearing acuity. 25.6% patients showed no improvement.

**Conclusion:** Our finding in present study is that CKD patients with hearing loss received significantly lesser haemodialysis sessions is interesting as it suggests a possible beneficial association between increasing number of dialysis sessions and hearing loss.

**Keywords:** Haemodialysis, Hearing loss, Sensori-neural hearing loss.

### Introduction

Chronic kidney disease (CKD) refers to a gradual and usually irreversible reduction of glomerular filtration rate (GFR) which can be caused by trauma, genetic disorders, infections and effect of drugs that are toxic to the kidneys.

Other disease conditions such as diabetes and hypertension increase the risk of an individual developing kidney failure. About 10% of the world's population is affected by various forms of kidney disease making it a global public health challenge. The association between chronic kidney disease (CKD) and hearing impairment was first reported more than 80 years ago by Alport, who described a case of familial kidney disease related to hearing

impairment. The etiopathogenetic mechanisms of Sensorineural hearing loss in CKD is due to osmotic alteration resulting in loss of hair cells, collapse of the endolymphatic space, edema and atrophy of specialized auditory cells and in some, complications of hemodialysis itself. Because of certain anatomic, physiological and ultrastructural similarities between the stria vascularis of the inner ear and basement membranes of glomeruli and evidence for similar antigenicity of the cochlea and kidney, may explain this association of CKD and SN loss can be explained to some extent. In patients with established CKD, multiple risk factors have been hypothesized to cause hearing loss such as use of hypertension ototoxic drugs, hypertension, nephrotoxic drugs, electrolyte disturbances, diabetes, particularly in association

with hypertension and hemodialysis itself and age of patient have been implicated in various studies. Despite the multitude of studies regarding hearing loss in CKD, some dark domains still persists regarding the role of haemodialysis and duration of disease. There is high rise in the prevalence of CKD in India due to rise in conditions such as diabetes and hypertension. Comparatively, hearing loss has been found to be more prevalent among CKD patients than the general population in different parts of the world ranging from 28% to 67% has been recorded in similar studies.

### Objective

1. To determine the pattern of sensorineural hearing loss (SNHL) in CKD patients on haemodialysis attending Medicine Department.
2. To study the association between haemodialysis and degree of hearing changes.

### Study Design

Case control, observational, analytical study

### Materials and Methods

**Study area:** Department of MEDICINE, Haemodialysis unit, Mursidabad Medical College, Berhampore. West Bengal.

**Study period:** November, 2016 – November, 2019.

**Ethical clearance:** Institutional ethics committee clearance was taken prior to the commencement of the study.

### Study sample

**Cases-**500 CKD stage 5 (End Stage Renal Disease, ESRD) patients aged 18 to 50 years who have undergone at least one session of haemodialysis. Particularly, age was limited to 50 years for purposes of excluding presence of presbycusis. CKD patients with conductive hearing loss and syndromic etiologies of CKD in which hearing loss is a known component, were excluded from this study.

**Controls=** As control group of 500, age and gender-matched healthy individuals were included in this study. These are the individuals without any history of ototoxic medications within the last three months, as well as those with no chronic diseases such as diabetes, hypertension, renal impairment and rheumatoid diseases, without family histories of hearing loss, no prolonged noise exposure, no history of otosclerosis, other ear diseases and ear surgery.

### Methodology

Written informed consent was obtained from CKD patients and controls.

- All patients were interviewed using a uniform proforma containing information on age, gender, and risk factors, including diabetes, hypertension, and history of ototoxic drug use.
- Time since diagnosis of chronic kidney disease and number of haemodialysis sessions were documented.
- Both case and control groups were subjected to have complete haemogram, coagulogram, fasting and post prandial blood sugar, serum LFT and RFT, electrolytes, viral serology of HIV 1, HIV 2 and HBs Ag.
- All CKD patients and controls were subjected otoscopic examination and hearing assessment using standard pure tone audiometry at 250, 500, 1000, 2000, 3000, 6000, 7000, and 8000 Hz. Because bone conduction hearing testing is limited to 4000 Hz, measurements  $\geq 4000$  Hz were performed using air conduction testing alone. The sensorineural hearing at high frequencies (8000 Hz) tested by air conduction is unaffected by and independent of middle ear effusion. 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 as moderately severe, 71–90 as severe, and  $>90$  db as profound hearing loss. Air and bone conduction thresholds were compared to identify the type and degree of hearing loss.

Descriptive statistical analysis has been carried out in this study. Results on continuous measurements are presented on mean standard deviation (minimum and maximum) and results on categorical measurements are presented in number (%). Chisquare test is used to compare the difference in proportions. The significance is assessed at 5% level of significance. Differences were considered significant if the  $p$  value was less than 0.05.

### Result and Analysis

**Table 1:** Stages of CKD

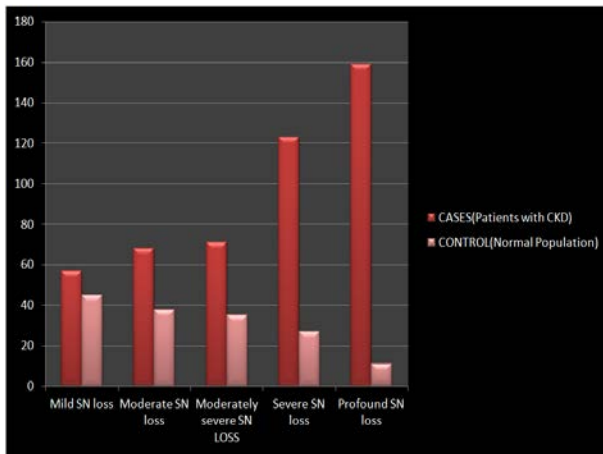
Stage	GFR (mL/min/1.73 m <sup>2</sup> )
0	>90
1	90
2	60-89
3	30-59
4	15-29
5	<15

**Table 2:** World Health Organization classification of hearing loss

Degree of hearing loss	dB hearing loss
Mild	26-40
Moderate	41-55
Moderately severe	56-70
Severe	71-91
Profound	>91

Five hundred Stage 5 CKD patients were subjected to study to quantify and measure the magnitude of SNHL. This was a case-control study. Five CKD patients succumbed to death in the course of the disease. They were excluded from the study. In the control group too one patient expired due to cerebrovascular accident (CVA).

After exclusion and inclusion criteria, among five hundred CRF control patients treated with hemodialysis, 357 were males and 143 females. Mean age in the case group was 51.9 for males and 42.5 for females. Duration of illness was 1–5 years (mean 3.2). In control group 315 patients were male and 184 patients were female. Mean age in the control group was 50.3 for males and 41.2 for females.



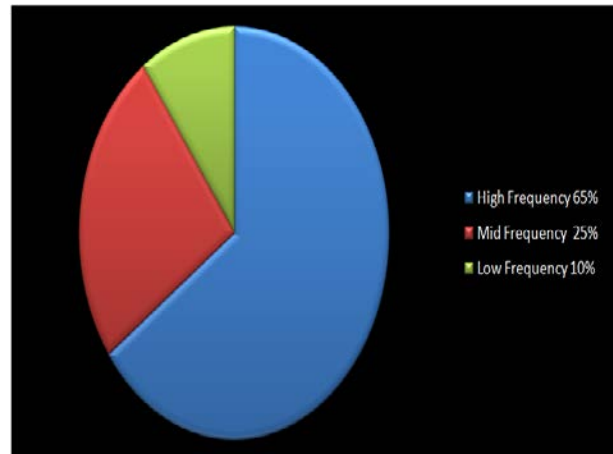
**Diagram 1:** Degree of SN hearing loss based on pure tone audiometry (PTA)

In CKD group, 96.5 % patients (478 out of 495) suffered from hearing loss and 3.5 % (17) patients had normal hearing. In control group, 31.2% (156 out of 499 patients) suffered from SN hearing loss and 68.2 % (343) have no hearing loss .

Among the Stage 5 CKD group, 11.9%(57 patients) had mild SN hearing loss, 14.2% had (68 patients) had

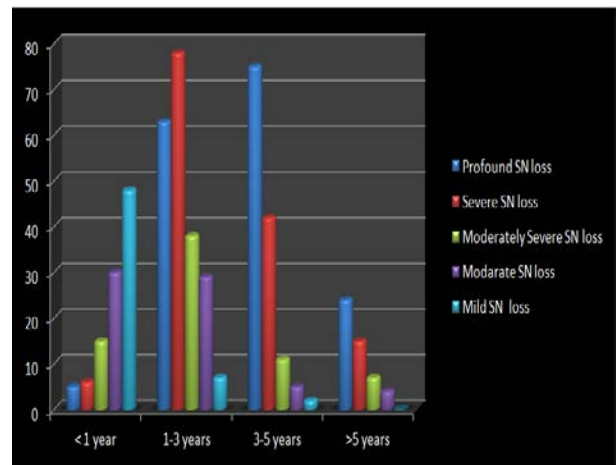
moderate SNHL (sensori-neural hearing loss), 14.8% (71 patients) had moderately severe SNHL , 25.7%(123 patients) had severe SNHL, and 33.2%(159 patients) had profound SNHL.

In the control group, 9% (45 people) had mild SNHL, 7.6%(38 people) had moderate SNHL, 7.1%(35 people) had moderately severe SNHL, 5.4%(27 people) had severe SNHL and 2.2%(11 people) had profound SNHL.



**Diagram 2:** Pattern of SN hearing loss in Stage-5 chronic kidney disease patients

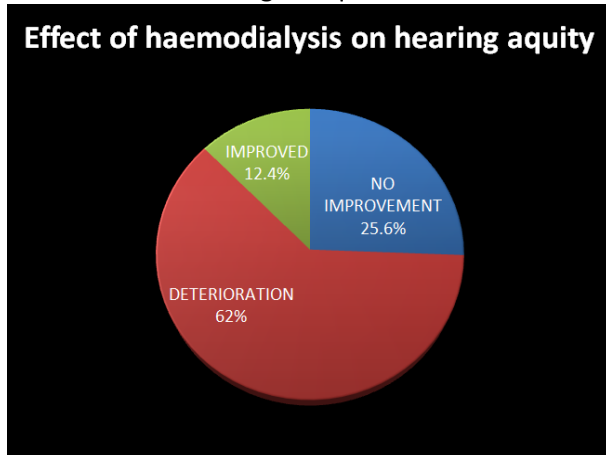
65 % Stage 5 CKD patients had high frequency (8000Hz) SNHL(62 % bilateral & 3% unilateral), 25% had mid frequency (4000Hz) SNHL (19% bilateral & 6 % unilateral) and 10 % had low or at speech frequency (500–2000 Hz) SNHL(8% bilateral & 2% unilateral).



**DIAGRAM 3:** Duration of disease among CKD patients with degree of hearing loss

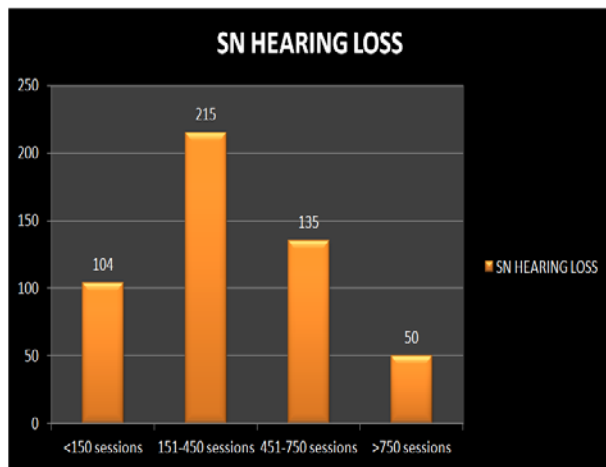
104 patients( 20.84%) who were on haemodialysis for less than 1 year presented with hearing loss (hearing threshold above 20 dB). 215 patients (43.08%) presented hearing loss who were on

haemodialysis for more than 1 year but less than 3 years. The patients who were on haemodialysis for more than 3 years but less than 5 years were 135(27.2 %) in number . 50 patients(10.1%) who were on haemodialysis for more than 5 years presented with hearing loss. The dominant hearing loss was obvious at high frequencies.



**Diagram 4:** Effects of hemodialysis on hearing acuity

Deterioration of hearing acuity occurred in 62% of the patients at the end of follow-up and 12.4% of the participants showed improvement in hearing acuity. 25.6% patients showed no improvement.



**Diagram 5:** Number of haemodialysis sessions in CKD patients with Sensori Neural Hearing loss

Among CKD patients with hearing loss, the majority of the patients, 215 patients received 151 to 450 sessions. 104 patients received less than 150 sessions. 135 patients received 451-750 sessions. 50 patients received more than 750 sessions.

## Discussion

A number of studies conducted in India and abroad have documented and published higher incidence of hearing loss among children and adults with chronic

renal disease. The prevalence of hearing loss in CRF greatly varies in different countries. In India, it was reported to be 63.5%, in Nigeria 67%, in Iran 46%, and in Croatia 63.6%. Earlier studies showed higher prevalences of hearing loss even upto 70%–75%. This variation could be due to differences in the age of patients, methods of assessment of hearing loss, or duration of CRF and hemodialysis.

The exact pathophysiology between hearing impairment and CKD is addressed in various ways. Over many years', research have linked CRF and hearing loss in patients with rare diseases like mitochondrial myopathy, lactic acidosis, stroke, Alport syndrome and Fabry's disease.

Electrolyte disturbances, particularly sodium, water imbalance, hypertension, Vitamin D deficiency, and elevated serum urea levels are some proposed mechanisms for hearing impairment in patients with CRF. Defects in the cationic gradient of endolymphatic fluid can adversely affect hearing. Along with these alterations in the peripheral and central nervous system, "uremic neuropathy," may lead to in hearing impairment in CRF. Di Paolo *et al.* reported a high incidence of nerve conduction dysfunction in patients with CRF. They found decreased conduction velocity in the sensory and motor units, with the sensory units being more compromised than the motor.

Rossini *et al.* were unable, to arrive at a definite conclusion regarding the effect of haemodialysis on hearing in CKD. In contrast, Peyvandi *et al.* proposed in a recent study that prevalence and severity of hearing loss increases with duration of CKD and haemodialysis.

Ozen *et al.* reported an improvement of 20 dB in the hearing of patients following hemodialysis. They suggested that changes in serum osmolality, BUN, and fluid retention may reverse the hearing impairment in post dialysis period. But changes in the dialysis method lead to wide fluctuations of these parameters. There are several more recent reports in the literature contradicting the "hearing improvement" finding. Visenscio and Gerber reported that pure tone thresholds did not change significantly after hemodialysis.

Our finding in present study is that CKD patients with hearing loss received significantly lesser haemodialysis sessions is interesting as it suggests a possible beneficial association between increasing

number of dialysis sessions and hearing loss. Contributory evident data to indicate beneficial role of haemodialysis on hearing in CKD patients is present in this study.

In our study deterioration of hearing occurred in 62% of the patients at the end of follow-up. 12.4% of the participants showed improvement in hearing acuity. 25.6% patients showed no improvement.

We also observed that hearing loss at high frequencies might be the most common audiometric abnormality in CKD patients, but not the typical one. This difference may be due to several reasons. First, the sample sizes in both studies were small (49 and 63 CKD patients, respectively). Second, Qin used high-frequency audiometry to assess the patients, possibly identifying patients with even mild abnormalities at higher frequencies not employed in conventional audiometry.

So these number of studies clearly established prevalence of hearing loss among CKD patients, but well-designed studies with larger sample sizes were needed to address relationships between hearing loss in CKD and haemodialysis. Also another important question that arises in this context is whether a blanket audiometric screening of all CKD patients would help identify mild hearing loss and prevent progression to severe degrees, especially if a beneficial role for haemodialysis can be definitely established in long-term prospective studies. This present study answers both of the questions to some extent.

This study found 96.5 % (478 patients) of CKD patients on haemodialysis had hearing loss, considerably higher than the normal population who had 31.2% hearing loss [FIGURE: 1]. In other words, mostly all stage 5 CKD patient on haemodialysis experiences some degree of hearing impairment. 11.9% (57 patients) had mild SN hearing loss, 14.2% had (68 patients) had moderate SNHL (sensori-neural hearing loss), 14.8% (71 patients) had moderately severe SNHL, 25.7% (123 patients) had severe SNHL, and 33.2% (159 patients) had profound SNHL. That is 40.5%, majority of the patients had moderately severe to severe SN loss. Hearing thresholds were abnormal in CKD patients on haemodialysis across all frequencies ranging from 250 Hz to 8 kHz. SN loss was high frequency in 65% patients, mid frequency in 25% patients and low frequency in 10% patients [FIGURE: 2]

The prevalence of hearing loss in CKD patients varies from

28 per cent to 77 per cent according to different studies. Notably, many older studies have shown higher prevalence of hearing loss, possibly due to small sample sizes. The prevalence of this study is **48.9%**.

The high prevalence of hearing loss at enrollment in the study reflects the significant effect of CRF on hearing function. Yet, the impact of hemodialysis on the hearing threshold after 18 months was still substantial. The hearing threshold deteriorated from  $30.5 \pm 15.1$  dB at the start of the study to  $45.2 \pm 11.3$  dB after 18 months, which was a highly significant difference ( $P < 0.001$ ). This study also showed that CKD patients with hearing loss received [ FIGURE: 5 ] significantly fewer haemodialysis sessions compared to those without hearing loss. Our finding that CKD patients with hearing loss received significantly fewer haemodialysis sessions is interesting as it suggests a possible beneficial association between increasing number of dialysis sessions and hearing loss.

Thus, it is evident that there are data to indicate contributory as well as beneficial roles for haemodialysis on hearing in CKD patients. The finding of Lasisi *et al.* supports this result. The role of hemodialysis in the occurrence of hearing loss among patients with CRF could be due either to changes in the fluid and electrolyte composition of endolymph or accumulation of amyloid materials in inner ear tissues. Aluminum toxicity associated with chronic dialysis may play a role in hearing loss.

Nikolopoulos *et al*, Ozturan and Lam, Stavroulaki *et al.*, and Pandey *et al.* showed that auditory functions and thus hearing acuity were not affected by hemodialysis, particularly short term dialysis, or at least in the first 5 years of treatment. In contrast, other researchers reported that hearing is improved by hemodialysis. Aspris *et al.* indicated that although there is improvement in neural auditory function following hemodialysis, it is not restored to a normal level. Gafter *et al.* concluded that although dialysis may have some temporary beneficial effect, the longterm effect is not assured. The acceptable explanation of hearing improvement particularly in low frequency hearing loss is that hemodialysis promotes normalization and stabilization of hydroelectric and metabolic changes in the endolymph that were induced by CRF, leading to

enhancement of neural conduction and restore hair cell function.

### Conclusion

Some mild degree of sensorineural hearing loss is commonly present in CKD patients undergoing haemodialysis. Though this hearing loss is mostly high frequency but other emerging studies marks significant presence of low frequency and mid frequency loss. These patients were likely to be older and had a significantly longer exposure to ototoxic drugs. Haemodialysis might have a promising effect on hearing loss in CKD patients, but further research by long-term prospective studies are required to link common pathophysiology between kidney dysfunction and cochlear impairment to potentially modify the normal care of CKD patients of higher stages. It should encourage clinicians to regularly question about hearing function in their preventive care protocols and to refer all CKD patients with hearing loss to otorhinolaryngologists for evaluation and rehabilitation.

### Abbreviation:

1. **CKD** =Chronic kidney disease
2. **CRF** =Chronic renal failure.
3. **SNHL** = Senserineural hearing loss
4. **ESRD**= End stage renal disease
5. **LFT**= Liver function test
6. **RFT** = Renal function test
7. **Hz** = Hertz
8. **CVA** =Cerebro vascular accident
9. **Db** = Decibel
10. **BUN**= Blood urea nitrogen.

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