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A Prospective Study of Evaluation of Hearing Threshold in Chronic Renal Failure Patients Pre and Post Hemodialysis in a Tertiary Care Centre.

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ABSTRACT

AIM:

To Study the changes in hearing threshold among patients diagnosed with chronic renal failure going to begin hemodialysis in our hospital.

OBJECTIVES:

PRIMARY OBJECTIVE:

Find the Hearing threshold among Chronic Renal Failure patients going to begin hemodialysis and the effect of hemodialysis on the hearing threshold.

SECONDARY OBJECTIVE:

- To assess the degree and type of Hearing loss in dialysis patients
- To find any correlation between duration of illness, stage of disease and age of patient
- To assess the risk factors like Diabetes, Hypertension, ototoxic drugs in chronic renal failure patients contributing to hearing loss.

NEED OF THE STUDY:

As the results available so far on the effect of hemodialysis on change of hearing threshold have variable results, we intend to do this study to know the change in hearing threshold in Chronic Renal Failure patients going to begin haemodialysis in our hospital set up. We also included the change in speech reception threshold values in relation to hemodialysis in our study.

Study site: Apollo Main Hospitals, Greams Road, Chennai.

Study Population: Patients above 15 years presenting in the Outpatient department of Apollo Main Hospitals, Chennai with Chronic Kidney Disease on Dialysis

Sample Size: 65

Study Design: Prospective study.

Study duration: February 2021 to July 2021.

Inclusion Criteria: 1. Patients above 18 years of age. 2. Patients diagnosed with Chronic Kidney Disease going to begin Hemodialysis.

Exclusion Criteria: 1. Patients younger than 18 years of age. 2. Patients who have undergone prior ear surgery. 3. Patients diagnosed as HIV positive undergoing dialysis. 4. Patients with Noise induced hearing loss. 5. Patients with Acute Renal Failure. 6. Patients with significant head injury.

METHODOLOGY:

Study will be carried over in the ENT and Nephrology Departments of Apollo main hospital.

Patients included in the study will be explained about the purpose of study and will be ensured that information collected from them would be kept confidential and would be used only for academic purpose. Written informed consent would be taken from each subject.

A thorough history will be taken from all the patients selected and complete ear, nose and throat examination is done.

Pure Tone Audiogram and Speech Audiometry will be done on all patients before starting dialysis and after three sessions of dialysis.

The pure tone audiometry and speech audiometry will be done with a computer audiometer - Grason Stadler 61 clinical audiometer in the sound - proof (acoustic) room in the ENT OPD.

The hearing acuity will be measured in dB at the frequencies 500 - 8000Hz. The average for the four frequencies 500Hz, 1000Hz, 2000Hz and 4000Hz will be recorded.

Air and bone conduction thresholds will be compared to identify the type and degree of hearing loss.

The duration of illness, dosage of diuretic and blood pressure will also be noted.

Hearing related questions including family history of hearing loss, drugs taken, past medical or

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surgical treatment of otologic conditions, diseases associated with hearing loss, and risk factors for ear disease. Other questions addressed exposure to noise at work.

Patients will be subjected to undergo the following investigations:Pure tone audiometry and speech audiometry before beginning hemodialysis and after 3 sessions of hemodialysis.

Nephrological investigations such as serum creatinine, blood urea nitrogen (BUN), eGFR and serum electrolytes.

INTRODUCTION:

Great advances have been made in the management of patient with chronic renal failure (CRF) on hemodialysis, so the life expectancy of these patients has increased dramatically. With increased patient survival and control of the disease, the side effects on other organs have started coming to light. Though, the management of CRF has seen advances including that in hemodialysis, hearing loss continues to cause disability in these patients.

RESULTS:

Though we have arrived at certain broad conclusions based on our results, yet we cannot presume to identify the exact aetiological factors responsible for hearing loss. The raised blood urea and serum creatinine levels does not predict the occurrence of sensorineural hearing loss (SNHL). The severity of hearing loss increases with the stage of the disease and the age of the patients but there is no significant correlation with sex of the patients. It is also inferred that hemodialysis is not a causative factor for SNHL, but there is a relationship between SNHL and CRF in high frequencies. However, presumably hemodialysis may have an ameliorative effect on hearing loss in CKD patients, an association that needs to be tested further by long term prospective studies.

CONCLUSION:

CRF patients are subject to wide fluctuations in hemodynamic and metabolic parameters over time. SNHL has a considerable prevalence in CRF patients. Evidence of possible correlation between renal function and hearing loss, as revealed by our study, could change how persons with CKD are treated in the future. It should encourage clinical nephrologists to include hearing function questions in their preventive care protocols and to refer all patients reporting hearing loss to a hearing health professional for evaluation and rehabilitation (e.g. hearing aids), and to advise patients to avoid further ototoxic medication treatment in order to preserve their hearing ability.

I. INTRODUCTION

Great advances have been made in the management of patient with chronic renal failure (CRF) on hemodialysis, so the life expectancy of these patients has increased dramatically. With increased patient survival and control of the disease, the side effects on other organs have started coming to light. Though, the management of CRF has seen advances including that in hemodailysis, hearing loss continues to cause disability in these patients.

Sensorineural hearing loss (SNHL) is more common in patients with chronic renal failure (CRF) than it is in the general population (prevalence of 20-40%). Chronic renal failure is characterised by gradually progressive loss of renal function. After the advent of haemodialysis (rearrangement of the liquid and solute content of the body in CRF), patients with renal disease live longer and with better quality of life. However, hearing loss (HL) is frequently seen in those patients undergoing dialysis which may impact the quality of life. The incidence of HL in the patients with CRF and on regular haemodialysis ranges from 20-80%.[1,2,3,4,5] The general consensus in audiometric findings among patients with chronic renal failure is that they have high frequency hearing loss with a notch at 6000Hz. This hearing loss is mostly sensorineural type and usually is diagnosed in long term CRF patients and it usually progresses in time.

The role of haemodialysis in the causation of SNHL is controversial, some authors have reported a depression in hearing threshold after haemodialysis while others are of the opinion that there is no relation between the two.[6,7,8,9] Despite variances in methodology and auditory function indices, the presence of hearing loss has been a common trend. The greater incidence of HL among patient with CRF has long been known and is constantly being verified by new researches.[10] Nevertheless, haemodialysis may have an important role in hearing loss in CRF patients. Long term dialysis results in accumulation of amyloid materials in many tissues including the inner ear.[11] Aluminium toxicity, which is seen in chronic dialysis patients, may also have a role in hearing loss.[11]

In 1927, Alport first described a case with associated hearing loss, in which kidney and cochlea are affected together.[12] Other rare

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illnesses or syndromes in which hearing loss (HL) is closely associated include Familial kidney disease like HDR (hypoparathryoidism, deafness, and renal dysplasia) syndrome, brachi-oto renal syndrome, Fabry disease, and MELAS (Mitochondrial myopathy, encephalopathy, lactic acidosis, and stroke) syndrome.[13,14,15,16]

A lot of studies have been undertaken to determine the prevalence and degree of hearing loss in patients on dialysis and to identify the association between hearing loss and factors like duration of kidney disease and the number of dialysis. Thodis et al. in their study found that hearing loss is more commonly reported finding than vestibular dysfunction.[10] Certain studies have reported that the lesion in the form of hearing loss is found in the cochlea, while other studies have identified retrocochlear involvement in addition to cochlear pathological abnormalities.[17]

Though the gross anatomy of cochlea and kidney differ, yet many similarities exist between the stria vascularis of the cochlea of the inner ear and renal nephron at the anatomical, physiological, pharmacological, pathological and ultra-structural levels.[18] They may have common antigenicity. The nephron and the stria vascularis of the cochlea have epithelial structures and a vascular supply that are in close contact. Both epithelial structures have enzymatic systems that depend on Na^+/K^+ - adenosine triphosphatases and have carbonic anhydrase. The cochlea and kidney have similar physiological mechanisms which include the active transport of electrolytes and fluid by stria vascularis and glomerulus respectively.[19] Different pharmacologic agents can cause both nephrotoxic and ototoxic effects.[20]

There are several potential mechanisms of HL in CRF patients that have been postulated in literature including deranged haemoglobin, electrolytes, blood urea, serum creatinine, hypertension, ototoxic medication,[3,5,7,21,22] effects of haemodialysis treatment itself,[1,23,24]plasma viscosity and vitamin D deficiency.[4,17] Osmotic changes resulting in loss of hair cells, collapse of endolymphatic space, oedema, atrophy of specialized auditory cells and some complications of haemodialysis were the aetiopathogenic mechanisms reported.[19,25,26] The inner ear is a complicated system that relies on water and electrolyte equilibrium to function properly. Hearing properties will be affected by a defect in the cationic gradient of endolymphatic fluid. Another possible cause of hearing loss in CRF is endolymphatic hydrops. This phenomenon could be the cause of low frequency sensorineural hearing loss (SNHL) that improves with hemodialysis.[7]

Age, diabetes, hypertension, and drugs that are both ototoxic and nephrotoxic are all shared risk factors for CKD and hearing loss. According to Zeigelboim et al., changes in blood pressure during haemodialysis, changes in osmotic pressure, ototoxic and nephrotoxic agents used in haemodialysis, and haemodialysis techniques play a role in the pathogenesis of hearing loss.[27] Hearing loss consequently reduces the quality of life in dialysis patients.

As the results available so far on the effect of dialysis in change of hearing threshold have variable results, we intend to do this study to know the change in hearing threshold in CRF patients going to begin haemodialysis in our hospital set up.We also included the change in speech reception threshold values in relation to hemodialysis in our study.

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II. MATERIALS AND METHODS

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III. RESULTS

Amongst 65 patients, 43 patients are Male and 22 patients are female. The age group range was between 18 years to 80 years. Out of 65 patients, 53 patients (81.5%) have sensorineural hearing loss at recruitment. Amongst 53 patients, 35 patients have mild hearing loss, 16 patients have moderate hearing loss and 2 patients have severe hearing loss. Post hemodialysis 54 patients found to have sensorineural hearing loss. Amongst 54 patients, 35 patients have mild hearing loss, 17 patients have moderate hearing loss and 2 patients have severe hearing loss. One patient who had normal hearing developed mild hearing loss and one patient who had mild hearing loss developed moderate hearing loss post hemodialysis.

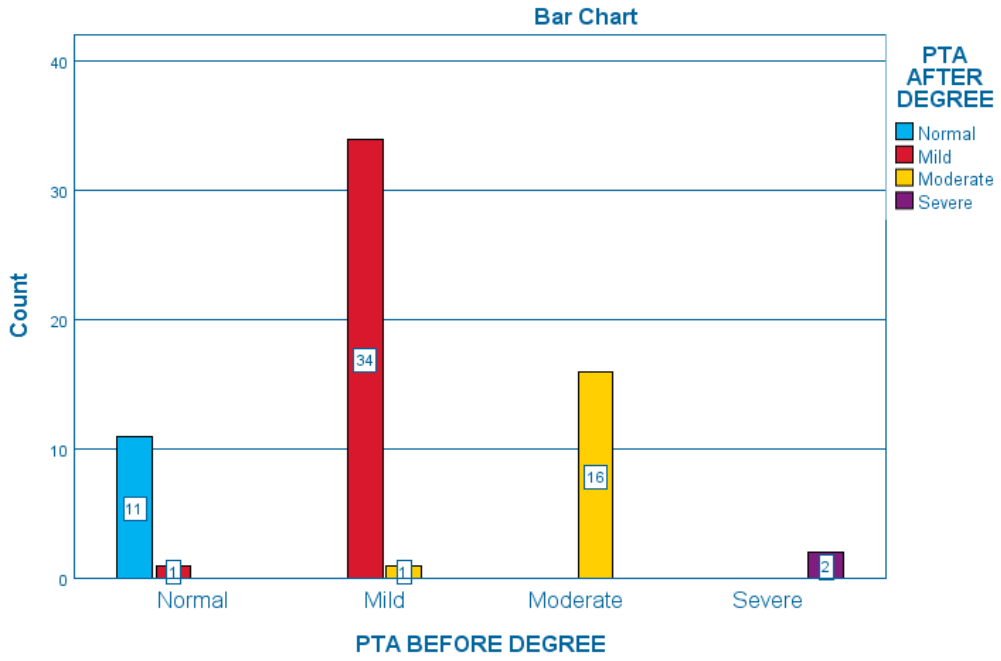

FIGURE 1: FREQUENCY OF HEARING LOSS AFTER DIALYSIS

- The range of Hearing threshold of the patients is between 15dB and 65dB at recruitment.
- The range of hearing threshold post hemodiaysis is between 17dB and 65dB.
- There increased hearing threshold in 30 patients post hemodialysis.
- The difference of hearing threshold pre and post hemodialysis in the patients were ranging from 5dB to 10dB.

Out of 65 patients, 51 patients have increased speech reception threshold at recruitment 53 patients have increased speech reception threshold after hemodialysis. There is a significant (p=0.001) change in speech reception threshold in patients after hemodialysis.

Out of 65 patients, 42 patients had a serum creatinine level more than 9mg/dl. Of them, 36 patients had hearing loss which included 2 with severe hearing loss and 10 with moderate hearing loss. There was statistically significant relationship between the serum creatinine level and hearing threshold.

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SERUM CREATININE	NORMAL	MILD HL	MODERATE HL	SEVERE HL
< 9 mg/dl	6	11	6	0
> 9 mg/dl	6	24	10	2

TABLE 1: COMPARISION OF SERUM CREATININE WITH DEGREE OF HEARING LOSS

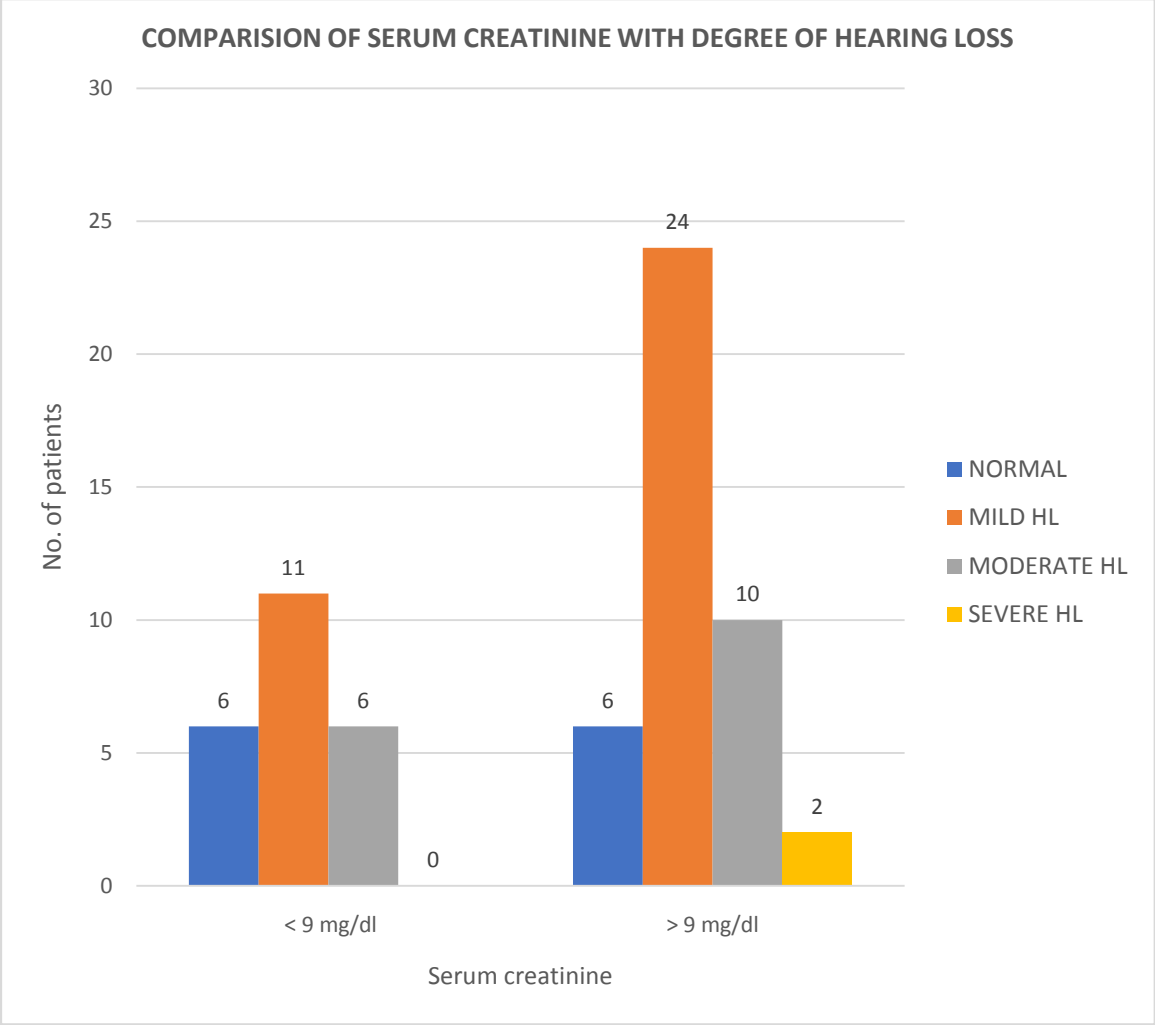

FIGURE 2: COMPARISION OF SERUM CREATININE WITH DEGREE OF HEARING LOSS

IV. DISCUSSION

Hearing loss in CKD population has been reported as being mainly sensorineural. Sensorineural hearing loss (SNHL) among patients with CRF has been a common finding in studies investigating the effect of renal failure on auditory function. The higher incidence of hearing loss among patients with CRF has been established and is constantly being verified by new studies.[1,2,3,4,18,28] The other causes of SNHL include age, diabetes, congenital hereditary nephropathy, ototoxic drugs such as furosemide or exposure to work (industrial related) and stroke.

In the present investigation participants with otosclerosis, tympanosclerosis, tympanic membrane perforation and HIV positive patients were excluded. Thus, CKD per se was associated with increased risk of SNHL independent of other known confounding variables. None of the participants in our study had the rare syndromes previously associated with hearing loss and renal disease.

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The prevalence of hearing loss in our study at recruitment is 81.5% and post hemodialysis is 83.1%. In the study done by Akeem et al, hearing loss at recruitment is 67% and post hemodialysis is 79%. Thus, hemodialysis may have an ameliorative effect on hearing loss in CKD patients.

CURRENT STUDY	83%
AKEEM ET AL	79%
CHARACHON ET AL	75%
KUSAKARI ET AL	60%
REDDY E K ET AL	63.5%

TABLE 2: COMPARISON OF PREVALANCE OF HEARING LOSS WITHVARIOUS STUDIES

According to the current study, hearing loss worsens with duration of CKD. Akeem Et Al, also found that, hearing loss worsens with duration of CKD. Henrich et al., concluded that SNHL is common in renal failure and it does worsen with duration of treatment.

According to the current study, hearing loss worsens with increased creatinine levels. The other blood investigations has no significant correlation as seen in the study conducted by Akeem Et Al. Akeem Et Al, also found that, hearing loss worsens with increased creatinine levels. Sahin and Varim also reported statistically significant differences in hearing thresholds and uremia. Inner ear dysfunction (including SNHL and vestibular dysfunction or a combination) was not linked to BUN, serum creatinine, potassium, sodium, calcium, or glucose levels, according to Kusakari et al. Alder et al. also opined that Na+, K+ activated ATPase in the cochlea is important in maintaining catonic gradients, suggesting further that inhibition of this enzyme system may be a contributing factor in inner ear dysfunction among uremic patients.[29] In the research study conducted by Sreedharan et al, serum creatinine and blood urea levels had a positive correlation with hearing thresholds.[30]

Hypertension and diabetes are independent risk factors for hearing loss, but in our study comorbidities did not give statistically significant correlation on effect of hearing loss. This may be attributed to the small sample size of the current study.

V. CONCLUSIONS

CRF patients are subject to wide fluctuations in hemodynamic and metabolic parameters over time. Though we have arrived at certain broad conclusions based on our results, yet we cannot presume to identify the exact aetiological factors responsible for hearing loss. The raised blood urea and serum creatinine levels does not predict the occurrence of sensorineural hearing loss (SNHL).

However, SNHL has a considerable prevalence in CRF patients. The severity of hearing loss increases with the stage of the disease and the age of the patients but there is no significant correlation with sex of the patients. It is also inferred that hemodialysis is not a causative factor for SNHL, but there is a relationship between SNHL and CRF in high frequencies. However, presumably hemodialysis may have an ameliorative effect on hearing loss in CKD patients, an association that needs to be tested further by long term prospective studies.

Evidence of possible correlation between renal function and hearing loss, as revealed by our study, could change how persons with CKD are treated in the future. It should encourage clinical nephrologists to include hearing function questions in their preventive care protocols and to refer all patients reporting hearing loss to a hearing health professional for evaluation and rehabilitation (e.g. hearing aids), and to advise patients to avoid further ototoxic medication treatment in order to preserve their hearing ability.

VI. RECOMMENDATIONS

- Regular otological assessment is necessary in CKD patients so as to detect early changes in hearing threshold.
- Pure tone audiogram annually may be used as a screening tool to detect early changes.
- This study can be further extended to know the confounding effect of other associated risk factors on hearing threshold.

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