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Hearing impairment in patients with Chronic Renal Failure

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INTRODUCTION

A number of anatomical, physiological, immunological, pharmacological and pathological similarities exist between the kidney and the cochlea [1]. Active transport of fluid and electrolytes by striae vascularis and the glomeruli suggest that both cochlea and kidney have similar physiological mechanisms [2]. Gradual and progressive destruction of nephrons leads to reduction in glomerular filtration rate eventually leading to increase in blood urea and serum creatinine, electrolyte imbalance, toxic accumulation, metabolic acidosis and disturbances of calcium metabolism. These patients are prone for bleeding diathesis, deranged calcium metabolism, hearing loss and neuropathy [3]. It is widely acknowledged that the inner hair cells of the cochlea are at risk to be damaged by a variety of metabolic, electrolytic and hormonal imbalances. A high incidence of sensorineural hearing loss (SNHL) has been reported in patients with Chronic Renal Failure (CRF) particularly involving higher frequencies [1-7]. However, the role of haemodialysis (HD) in the causation of hearing loss is unclear. While some authors have reported fluctuations in hearing in patients undergoing HD, others have reported impairments of hearing following HD and its subsequent improvement following renal transplantation. Some authors are of the opinion that there is no relation between hearing and HD [6-9]. The study was undertaken to assess SNHL in patients with CRF and to compare hearing thresholds of patients treated conservatively with those treated with HD in comparison with age and sex matched normal control subjects. An attempt was also made to correlate the hearing threshold (HT) with the duration of disease and duration of HD as also to study the association of hearing loss (HL) with the biochemical parameters namely blood urea nitrogen (BUN), serum creatinine and serum electrolytes.

METHODOLOGY

A prospective cross-sectional study was undertaken from June 2013 to December 2013. Prior clearance was taken from the Institutional Ethics committee for the conduct of study. A total of 120 subjects were enrolled into the study. The study group comprised of 80 patients of whom 40 had CRF and were on conservative management while, 40 were undergoing HD at the Nephrology unit of a tertiary referral hospital in South India. Patients were excluded if they had uremic encephalopathy or severe illness precluding them from responding at audiometry, local otological disease, previous otological trauma or surgery, gave a history of hearing loss prior to the development of CRF, exposure to ototoxic drugs prior to initiation of treatment for chronic renal failure, occupational noise exposure or had a family history of hearing loss. Forty healthy volunteers having normal renal function and not fitting into any of the exclusion criteria used for selection of study group subjects age and sex matched with the study group were included in the control group. Signed informed consent was taken from all subjects included in the study. All subjects selected for the study underwent detailed clinical examination including otological examination. They were subjected to blood investigations which included blood urea nitrogen (BUN), serum creatinine and serum electrolytes. Pure Tone Audiometry was done in a sound proof room, using a calibrated Interacoustics Clinical audiometer-AC-40 (Denmark). The transducers used for the testing were TDH 39 Supra Aural Head phones and Radio Ear B 71 bone vibrator. Modified Hughson-Westlake procedure (ASHA 1978) was used for the threshold estimation. The threshold was determined based on the American National Standard Institute (ANSI 1978, 1986). The threshold was obtained across all the frequency octaves from 250 Hz to 16,000 Hz. Quantitative assessment of degree of hearing loss was done based on the Clark's (1981) modification of Goodman classification of severity of hearing loss

(Table 1)[9].

The data obtained thereof was processed and analysed using the Windows- Statistical Package for Social Sciences (SPSS Inc, Chicago, Illinois, USA, Version 16.0). One- way Analysis of Variance (ANOVA) followed by Post-hoc tukey test was used to assess the continuous variables in audiometry. As there were three groups (CRF, HD and control), One- way ANOVA and Post-hoc tukey test was used to assess the variations within the subgroups. Independent t test was used to find out the correlation of hearing loss with duration of the CRF and HD. Pearson's correlation coefficient was used to find the correlation between the biochemical parameters and the hearing threshold.

RESULTS

A total of 120 subjects of which 40 were CRF patients on conservative management, 40 on HD and 40 controls were included in the study. One patient in the CRF group had to be excluded due to deterioration in health status. The mean age of patients in CRF group was 45.69 ± 16.47 years (Mean ± Standard deviation (SD)) while that of patients in HD group was 49.4 ± 13.36 years. Control group subjects had a mean age of 42.28 ± 13.85 years. The age and gender distribution of subjects across groups is shown in Table 1.

Table 1 – Age and sex distribution of patients in Chronic Renal Failure, Haemodialysis and Control groups.

CHRONIC RENAL FAILURE				HAEMODIALYSIS			CONTROLS		
Age group (years)	Male	Female	Total	Male	Female	Total	Male	Female	Total
20-29	6	2	8	1	1	2	7	3	10
30-39	9	1	10	8	2	10	4	0	4
40-49	2	0	2	5	1	6	9	4	13
50-59	6	2	8	8	2	10	7	0	7
60-69	6	5	11	10	0	10	5	0	5
70-79	0	0	0	2	0	2	0	1	1
Total	29	10	39	34	6	40	32	8	40

Mean disease duration in chronic renal failure and haemodialysis was 17.33 months and 23.13 months respectively.

SNHL was observed in 74.3% (n=29) of CRF patients, all of whom had bilateral SNHL. Of the patients on HD, 77.5 % (n=31) had SNHL of whom, 96.7% (n=30) had bilateral SNHL and 3.2% (n=1) had unilateral SNHL. 32.5% (n= 13) of the controls had SNHL of whom, 84.61% had bilateral HL and 15.38% had unilateral HL. The degree of hearing loss was observed to be higher in patients treated conservatively or with HD as compared to controls irrespective of the age (Table 2).

Table 2 – Degree of HL in CRF, HD and Control groups in relation to age

Group	Age (years)	Degree of HL						Total
		Slight	Mild	Moderate	Moderately severe	Severe	Profound	
CRF	<40	0	12.5% (1)	37.5% (3)	50% (4)	0	0	27.5% (8)
	≥40	0	4.7% (1)	28.5% (6)	42% (9)	14.2% (3)	9.5% (2)	72.4% (21)
HD	<40	14.2% (1)	28.5% (2)	42.8% (3)	14.2% (1)	0	0	22.5% (7)
	≥40	14.2% (1)	16.6 % (4)	37.5% (9)	41.6% (10)	0	0	77.4% (24)
CONTROL	<40	0	0	0	0	0	0	0
	≥40	0	61.5% (8)	30.7% (4)	0	0	7.6% (1)	32.5% (13)

The mean hearing thresholds were relatively higher across all frequencies in both the CRF and HD group. While slight to minimal HL was seen in the frequencies ranging from 250 Hz- 2000 Hz, moderate to moderately severe HL was observed in the 4000 Hz to 16,000 Hz frequency range in the CRF group. In the HD group, slight to mild HL loss was observed in 250- 2000 Hz frequency range while moderate HL was noted in the 4000-16,000 Hz frequency range (Fig 1 and 2). Involvement of higher frequencies was seen in almost all the patients having HL in both CRF and HD groups.

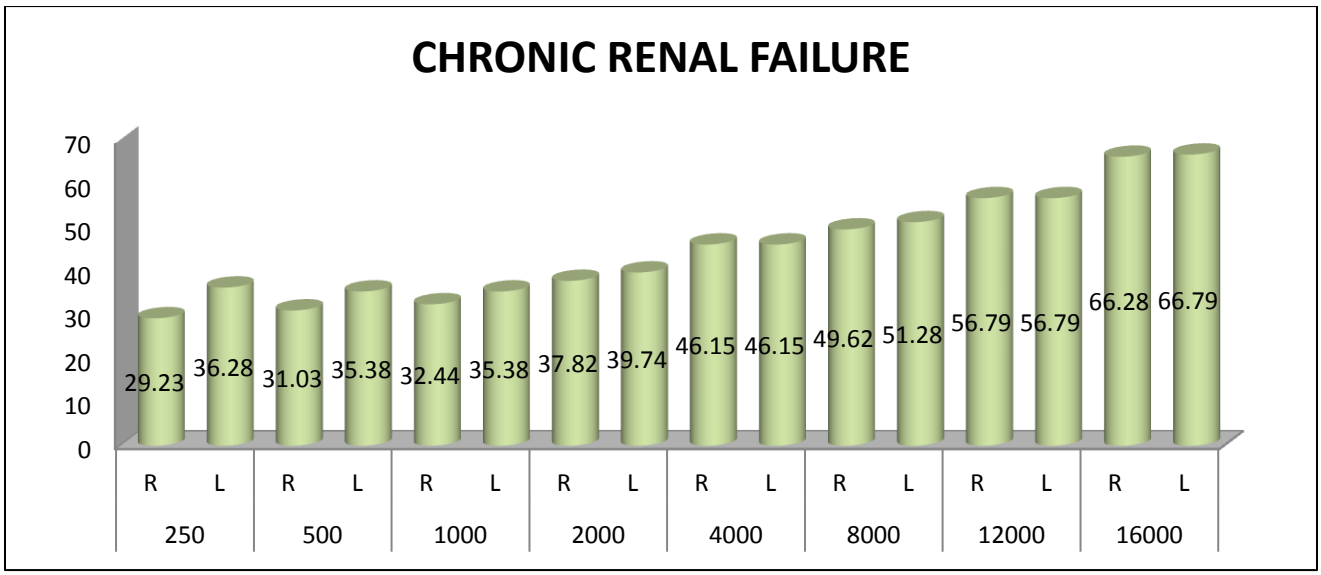

Fig 1: Mean hearing thresholds at different frequencies in patients with chronic renal failure.

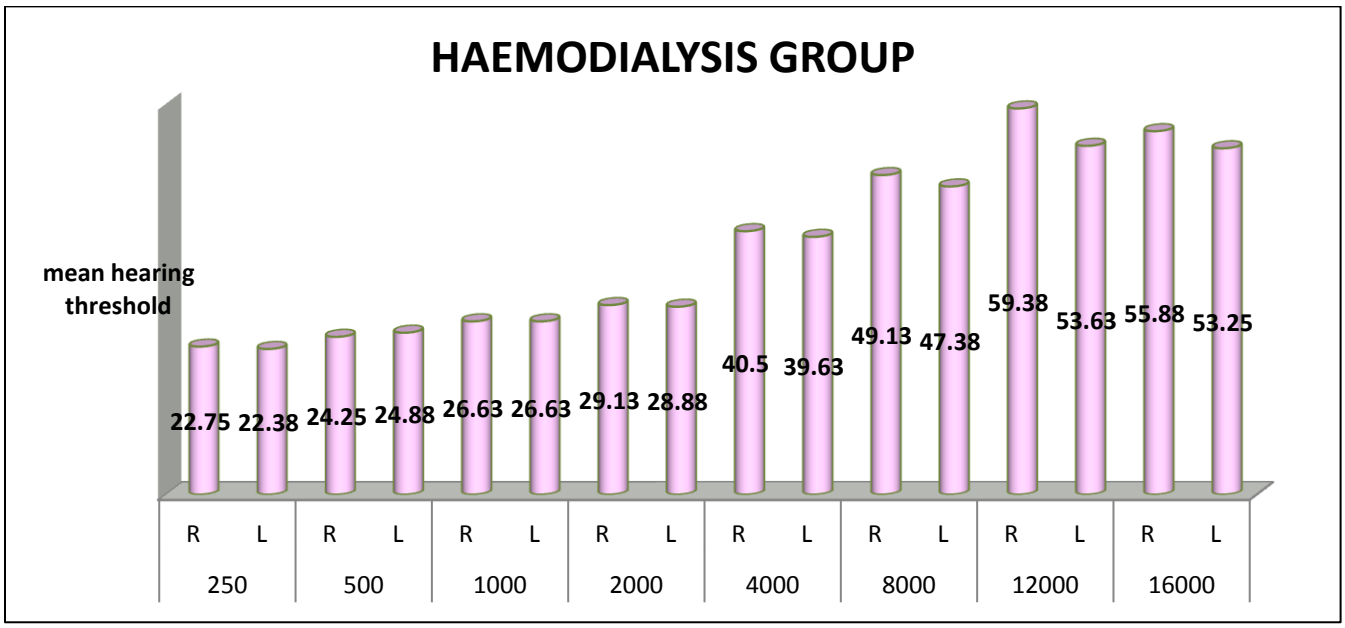

Fig 2: Mean hearing thresholds at different frequencies in patients undergoing haemodialysis.

On comparing controls with CRF group and also with HD group, it was noted that elevation in hearing thresholds (HT) of right ear was highly significant (P<0.001) from 2000- 16000 Hz and significant (P<0.05) from 250Hz – 1000Hz. In the left ear, the increase in HT was highly significant across all frequencies. Mean HTs were significantly lower in patients treated with HD as compared to those treated conservatively (Tables –3, 4, 5).

Table 3: Comparison of hearing thresholds between Chronic Renal Failure group and Controls.

		CRF		CONTROL		
FREQ IN Hz		MEAN	SD	MEAN	SD	P
250	R	29.23	20.76	17.25	9.47	0.03*
	L	36.28	21.266	18.63	10.252	**<0.001****
500	R	31.03	19.874	20.63	9.948	0.016*
	L	35.38	20.818	20	9.541	**<0.001****
1000	R	32.44	20.928	18.25	12.586	0.002*
	L	35.38	20.532	16.63	11.288	**<0.001****
2000	R	37.82	22.821	18	13.243	**<0.001****
	L	39.74	24.654	17.75	12.087	**<0.001****
4000	R	46.15	26.61	22.25	15.062	**<0.001****
	L	46.15	26.864	21.63	13.653	**<0.001****
8000	R	49.62	26.417	25.13	18.449	**<0.001****
	L	51.28	26.992	24.38	16.06	**<0.001****
12000	R	56.79	22.287	33.25	17.851	**<0.001****
	L	56.79	22.58	33.5	12.77	**<0.001****
16000	R	66.28	21.39	38.13	14.442	**<0.001****
	L	66.79	23.013	35.88	13.816	**<0.001****

Table 4: Comparison of Hearing thresholds between Hemodialysis group and controls

		HD		CONTROL		
FREQ IN Hz		MEAN	SD	MEAN	SD	P
250	R	22.75	12.087	17.25	9.47	0.03*
	L	22.38	12.959	18.63	10.252	**<0.001****
500	R	24.25	15.382	20.63	9.948	0.016*
	L	24.88	15.709	20	9.541	**<0.001****
1000	R	26.63	17.149	18.25	12.586	0.002*
	L	26.63	20.14	16.63	11.288	**<0.001****
2000	R	29.13	18.977	18	13.243	**<0.001****
	L	28.88	21.765	17.75	12.087	**<0.001****
4000	R	40.5	20.312	22.25	15.062	**<0.001****
	L	39.63	23.381	21.63	13.653	**<0.001****
8000	R	49.13	22.671	25.13	18.449	**<0.001****
	L	47.38	29.978	24.38	16.06	**<0.001****
12000	R	59.38	17.104	33.25	17.851	**<0.001****
	L	53.63	19.115	33.5	12.77	**<0.001****
16000	R	55.88	7.67	38.13	14.442	**<0.001****
	L	53.25	9.644	35.88	13.816	**<0.001****

Table 5: Comparison of Hearing thresholds between Chronic Renal Failure Group And Haemodialysis Group.

		CRF		HD		
FREQ IN Hz		MEAN	SD	MEAN	SD	P
250	R	29.23	20.76	22.75	12.087	0.03*
	L	36.28	21.266	22.38	12.959	**<0.001****
500	R	31.03	19.874	24.25	15.382	0.016*
	L	35.38	20.818	24.88	15.709	**<0.001****
1000	R	32.44	20.928	26.63	17.149	0.002*
	L	35.38	20.532	26.63	20.14	**<0.001****
2000	R	37.82	22.821	29.13	18.977	**<0.001****
	L	39.74	24.654	28.88	21.765	**<0.001****
4000	R	46.15	26.61	40.5	20.312	**<0.001****
	L	46.15	26.864	39.63	23.381	**<0.001****
8000	R	49.62	26.417	49.13	22.671	**<0.001****
	L	51.28	26.992	47.38	29.978	**<0.001****
12000	R	56.79	22.287	59.38	17.104	**<0.001****
	L	56.79	22.58	53.63	19.115	**<0.001****
16000	R	66.28	21.39	55.88	7.67	**<0.001****
	L	66.79	23.013	53.25	9.644	**<0.001****

7.69% (n=3) and 15% (n= 6) had diabetes mellitus in the CRF group and HD group respectively. Hypertension was observed in 53.85% (n= 21) in CRF group and in 65% (n=26) in HD group. HL was observed in all the diabetic patients in both groups. Among hypertensives, 76.19% (n=16) in the CRF group and 84.61% (n=22) in the HD group had hearing loss.

Patients were divided into 2 subgroups based on the duration of disease/ HD i.e those with disease/on HD for 2 years and less and those with disease/on HD for more than 2years. No significant correlation was observed between the duration of CRF and HL or the duration of HD and HL.None of the biochemical parameters studied correlated significantly with the hearing thresholds in the CRF group.

DISCUSSION

Sensorineural hearing loss has been reported to occur more frequently among patients with CRF in contrast to the general population. Higher frequencies are observed to be more involved in most studies in literature [1-7]. The same has also been observed in the present study. Previous studies done in the state of Uttar Pradesh and Madhya Pradesh in India have reported the prevalence of SNHL to be 73.07% and 78.25% respectively. It was also inferred that the method of treatment (whether conservative or haemodialysis) probably did not have any bearing on the hearing [3, 11]. In this study comprising 79 patients with CRF, SNHL was observed in 75.94% of patients. Mean hearing thresholds were elevated in both CRF and HD group as compared to controls, although higher elevation was noted in high frequencies (4000-16,000Hz). Physiological similarities in fluid and electrolyte shifts in the stria vascularis of cochlea and kidney have been conjectured to elucidate the relationship between CRF and HL. Loss of hair cells from osmotic alterations, collapse of endolymphatic space, oedema and atrophy of specialized auditory cells, associated diseases like diabetes and hypertension, ototoxic medications and hemodialysis itself have been postulated to cause HL [1,12,13]. Reports pertaining to the contribution of hemodialysis to HL in CRF lack consistency. Some reports document further elevation in HTs following HD [6, 9, 12, 14], while others report an improvement in hearing following HD in the lower frequencies with little change in middle and high frequencies. The low frequency HT is believed to be related to endolymphatic hydrops and improvement in low frequency HT has been attributed to change in fluid and electrolyte composition of endolymph following treatment [7]. Many authors have not observed any change in audiometric thresholds following hemodialysis, thereby concluding that HD did not affect hearing in CRF patients [15,16,17]. Observations of this study revealed better hearing in patients treated with HD in contrast to patients treated conservatively. However, this study did not compare the hearing of CRF patients before and after treatment with HD and so it is difficult to comment if HD did have an impact on hearing acuity. Another limitation of this study is that, although we excluded patients who gave a history of intake of ototoxic medications prior to starting treatment for CRF, most patients do receive diuretics as part of the treatment protocol and so ototoxicity cannot be completely ruled out as a cause for the HL. Similarly, antihypertensives and antidiabetic agents could also not be avoided in patients those who have diabetes or hypertension. No significant relationship has been found between hypertension and usage of ototoxic drugs in treatment of CRF with the HL in previous studies [3, 14].

There was no significant correlation between the duration of CRF or HD with the hearing thresholds in this study. This observation is in accordance with observations of previous studies [3, 17, 18].

Audiometric thresholds were not observed to correlate positively with the biochemical parameters such as BUN, Serum creatinine or serum electrolytes [8, 13, 19].

CONCLUSION

SNHL was observed in majority of patients with CRF, particularly involving the higher frequencies. Most patients had moderate to moderately severe hearing loss irrespective of whether they were treated conservatively or by HD. However, patients treated with HD had better hearing in contrast to those treated conservatively. The duration of disease or biochemical parameters did not show any significant relationship with the hearing loss. Care of patients with CRF should include hearing assessment with audiometry, avoidance of ototoxic medications to the extent possible and fitting of hearing aids for rehabilitation.

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