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Original Article

Sensorineural hearing loss in patients with chronic renal failure on hemodialysis in Basrah, Iraq

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Abstract

Objectives: The objective of this study is to determine the effect of hemodialysis on the hearing threshold in patients with chronic renal failure (CRF). **Materials and Methods:** Fifty-nine patients with CRF on regular hemodialysis were followed up for 1 year with a pure-tone audiometric examination every 6 months. **Results:** The mean age of the patients was 41.8 ± 9.2 years (range: 17–50 years). At the beginning of the study, 39 patients (66.1%) had sensorineural hearing loss (SNHL). During the 12-month follow-up, 6 more patients developed SNHL giving a point prevalence rate of 76.3% at the end of the study. The hearing loss was more evident in the higher frequencies. Of the studied patients, 64.4% showed deterioration of the hearing threshold. The mean hearing threshold at the beginning of the study was 29.2 ± 21.1 dB versus 36.9 ± 17.3 dB at the end of the study ($P < 0.001$). No significant relation was found between age, sex, serum electrolytes, blood urea, and duration of CRF and hearing loss. Multivariate analysis showed that the duration of hemodialysis was the only significant independent predictor of SNHL. **Conclusion:** SNHL is common in patients with CRF on hemodialysis. It was mild to moderate in the majority of patients. Hearing impairment was most obvious at the high frequencies. Most of the patients showed further deterioration in the hearing threshold with the duration of dialysis.

Keywords: *Basrah, Hearing loss, Hemodialysis, Prevalence, Renal failure*

Introduction

Sensorineural hearing loss (SNHL) is considerably more prevalent in patients with chronic renal failure (CRF) than in the general population. It ranges from 28% to 77% [1,2]. Although all frequencies can be affected by CRF, hearing impairment at high frequencies is most common [3].

In addition to antigenic similarity [4], the cochlea and kidney have similar physiological mechanisms, namely, the active transport of fluid and electrolytes achieved by the stria vascularis in the cochlea and the glomeruli in the kidney [5]. It was previously confirmed that the cochlea is affected by the systemic metabolic, hydroelectrolytic, and hormonal alterations that are associated with CRF [6].

Several variables may contribute to the etiopathogenetic mechanisms of hearing loss in CRF including factors related to the severity and duration of the disease, electrolyte disturbances, ototoxic drugs, age, comorbid conditions such as diabetes mellitus and hypertension, and hemodialysis [7-9]. Despite the abundance of early and recent studies on the role of hemodialysis in hearing loss, the results are still debated. Some have reported that hemodialysis treatment has no effect on auditory function at least in the first 5 years of treatment [10-12] while others indicated a deleterious effect of hemodialysis on hearing acuity [13-15].

Taking into consideration the importance of hearing loss in CRF and the diversity of its extent and the effect of hemodialysis on its severity, this study was carried out to determine the impact of hemodialysis on SNHL in patients with CRF in Basrah, Iraq.

Materials and methods

Study design and setting

This prospective study was done at the Otolaryngology and Haemodialysis units in Basrah General Hospital from December 2014 to December 2016.

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Patients

The study population was patients with CRF on chronic regular hemodialysis for different durations. The inclusion criteria were patients with Stage 5 CRF on hemodialysis regardless of the duration of renal failure or dialysis. The exclusion criteria included age >50 years, history of chronic use of ototoxic drugs, chronic suppurative otitis media, acoustic neuroma, childhood-onset hearing loss or hearing loss before the onset of chronic kidney disease, excessive or chronic noise exposure, otological trauma or surgery, renal transplantation, and conductive hearing loss. Eighty-one consecutive patients admitted to the hemodialysis unit were targeted. Fourteen patients were excluded according to the exclusion criteria. In addition, eight patients died during the follow-up period. The remaining 59 patients (33 males and 26 females) representing the final sample size were involved in the study. Each patient was followed up for 12 months after the initial examination.

Data collection

The patients were interviewed about their sociodemographic characteristics and medical history. Otological examination and tympanometry were done to exclude conductive hearing loss and external and middle ear pathologies. Pure-tone audiometric examinations were performed at admission, after 6 months, and after 12 months by the same experienced audiologist, using a computer audiometer BA 20 Kamplex (AA222, Interacoustics, Assens, Denmark) in a soundproof room. The hearing thresholds were measured in decibels (dB) at the frequencies 500–8000 Hz. The average for the four frequencies, i.e., 500, 1000, 2000, and 4000 Hz were recorded for each patient from values obtained for both ears, and hearing loss was defined as an average hearing threshold >20 dB [16].

Written informed consent was obtained from each patient before enrollment in the study following a detailed explanation of the objectives and protocol of the study. This study was conducted in accordance with the ethical principles stated in the Declaration of Helsinki and approved by the Ethical Committee of the College of Medicine, University of Basrah.

Statistical analysis

The data were analyzed using the SPSS (SPSS Inc., Chicago, IL, USA) version 23. Categorical measurements are presented in numbers and percentages while continuous variables are presented as means ± standard deviations. A paired Student's *t*-test was used to determine the significance of differences in mean hearing acuity at the start of the study and subsequent measurements whereas Chi-square or Fisher's exact tests were used to find the significance of differences in categorical parameters. The Pearson correlation coefficient was used to find the correlation between hearing loss and the duration of hemodialysis. Logistic regression analysis was performed to examine independent predictors of hearing loss. $P < 0.05$ was considered statistically significant.

Results

Fifty-nine patients were enrolled in this study (33 [55.9%] men and 26 [44.1%] women). The mean age of the studied population was 41.8 ± 9.2 years (range: 17–50 years). Patients with hearing loss showed a significantly longer duration of CRF and hemodialysis than those without hearing loss. No significant differences were noted between patients with and without hearing loss for any of the remaining studied factors [Table 1].

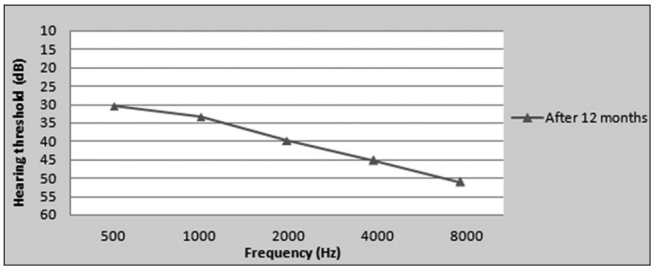

Figure 1: The mean hearing thresholds at frequencies of 500–8000 Hz at the end of the study (12 months)

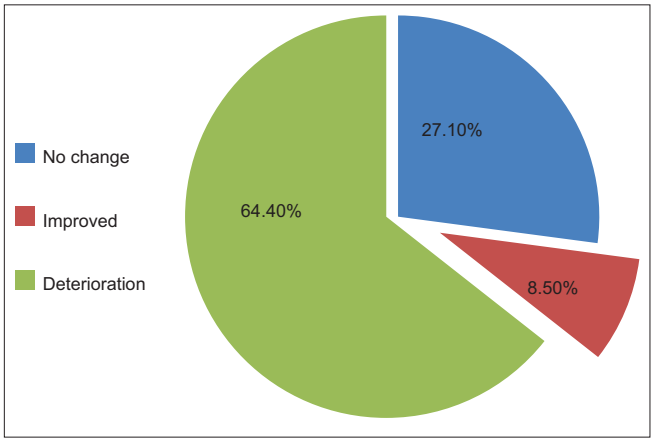

Figure 2: Effects of hemodialysis on hearing acuity

Hearing loss (hearing threshold above 20 dB) was detected in 39 patients (66.1%) at the start of the study. After 6 months, another 4 patients developed hearing loss giving a point prevalence rate of 72.9%. At the end of follow-up (12 months), 45 patients were found to have hearing loss with a point prevalence rate of 76.3% and an incidence rate of 30%.

The mean hearing loss for all frequencies at the start of the study was 29.2 ± 21.1 dB HL and increased to 35.3 ± 18.9 dB HL after 6 months, a highly significant difference ($P < 0.001$). At the end of the study, the mean hearing loss became 36.9 ± 17.3 dB HL, a highly significant difference ($P < 0.001$) compared to that at the start of the study [Table 2]. The dominant hearing loss was obvious at high frequencies [Figure 1].

Deterioration of hearing acuity occurred in 64.4% of the patients at the end of follow-up and 8.5% of the participants showed improvement in hearing acuity [Figure 2].

A significant positive correlation was found between the duration of hemodialysis and hearing loss ($r = 0.718$, $P < 0.001$).

The independent effects of the studied variables for hearing loss were examined using multivariate linear logistic regression analysis [Table 3]. At 6 months, the duration of dialysis and age were independent factors, which predicted the variation in the hearing threshold. At 12 months, the duration of dialysis was the only significant factor that predicted the impact of

Table 1: Baseline patient data

Characteristic	Total (*n*=59)	Patients with HL (*n*=39)	Patients without HL (*n*=20)	*P*
Age	41.8±9.2	43.0±8.9	39.4±9.5	0.149
Male:female ratio	1.27	1.29	1.22	0.918
Duration of hemodialysis (years)	3.4±2.9	4.1±3.2	1.9±1.3	0.006
Presence of HTN, DM, or both, percentage	94.9	94.9	95.0	0.983
Serum potassium (mmol/L)	4.7±0.7	4.6±0.7	4.9±0.7	0.119
Serum sodium (mmol/L)	141.7±8.8	141.3±8.9	142.5±8.6	0.604
Serum calcium (mg/dL)	4.1±0.6	4.1±0.5	4.0±0.6	0.506
Serum blood urea (mg/dL)	194.8±39.9	194.9±42.0	194.7±39.4	0.983
Serum creatinine (mg/dL)	9.5±1.5	9.6±1.5	9.3±1.6	0.529
Sessions of dialysis (/week)				
2	34 (57.6)	24 (70.6)	10 (29.4)	0.419
3	25 (42.4)	15 (60.0)	10 (40.0)	
Duration of chronic renal failure (years)				
<2	27 (45.8)	16 (59.3)	11 (40.7)	0.006
2-5	19 (32.2)	10 (52.6)	9 (47.4)	
>5	13 (22.0)	13 (100.0)	0	

Data are presented as mean±SD or *n* (%) unless otherwise indicated. HL: Hearing loss, HTN: Hypertension, DM: Diabetes mellitus, SD: Standard deviation

Table 2: Effects of hemodialysis on hearing loss

Time of audiometric examination	Patients with HL, *n* (%)	HL in dB (mean±SD)	*P*
Baseline	39 (66.1)	29.2±21.1	Reference
6 months	43 (72.9)	35.3±18.9	<0.001
12 months	45 (76.3)	36.9±17.3	<0.001

SD: Standard deviation, HL: Hearing loss

Table 3: Multiple regression analysis

Variable	β	R^2	*P*
After 6-month follow-up			
Duration of dialysis	0.630	0.428	<0.001
Age	0.206	0.470	0.040
After 12-month follow-up			
Duration of dialysis	0.718	0.515	<0.001

dialysis on hearing loss (β =0.718, $P < 0.001$). It accounted for 51.5% of the variation in the hearing threshold.

Discussion

Hearing impairment, particularly SNHL, in patients with CRF is a common finding in many studies investigating the influence of renal failure on hearing [9]. The prevalence of hearing loss in CRF patients varies greatly in different countries. In India [17], it was reported to be 63.5%, in Nigeria 67% [18], in Iran 46% [19], and in Croatia 63.6% [20]. Earlier studies showed higher prevalences of hearing loss (70%–75%) [21,22]. This variation could be due to differences in the age of patients, methods of assessment of hearing loss, or duration of CRF and hemodialysis [23].

Electrolyte disturbances, particularly sodium, water imbalance, hypertension, Vitamin D deficiency, and elevated serum urea levels, are proposed mechanisms for hearing impairment in patients with CRF [2,24-26]. Defects in the cationic gradient of endolymphatic fluid can change hearing properties [27]. Furthermore, alterations in the peripheral and central nervous system, "uremic neuropathy," may be involved in hearing impairment associated with CRF [28,29]. Di Paolo *et al*. [30] 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.

In this study, SNHL was found in 39 patients (66.1%) at the start of the study. It was mild to moderate in 57.6% of the patients, comparable to that reported by Reddy *et al*. [17] At the end of the study, six more patients in the initially normal group exhibited hearing loss giving an incidence rate of 30% and a prevalence rate of 76.3%. Similarly in Baghdad, Iraq, Aloubaide *et al*. [31] reported an SNHL incidence rate of 36.9% among patients with CRF on regular hemodialysis who were followed up for 7 months. 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 12 months was still substantial. The hearing threshold deteriorated from 29.2 ± 21.1 dB at the start of the study to 36.9 ± 17.3 dB after 12 months, which was a highly significant difference ($P < 0.001$). The finding of Lasisi *et al*. [18] 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 [18] or accumulation of amyloid materials in inner ear tissues. Aluminum toxicity associated with chronic dialysis may play a role in hearing loss [24]. However, the effect of hemodialysis on hearing function remains controversial.

Nikolopoulos *et al*. [24], Ozturan and Lam [5], Stavroulaki *et al*. [7], and Pandey *et al*. [12] showed that auditory functions were not affected by hemodialysis, particularly

short-term dialysis [9,11], or at least in the first 5 years of treatment [10,21].

In contrast, other researchers reported that hearing is improved by hemodialysis. Aspris *et al*. [32] indicated that although there is improvement in neural auditory function following hemodialysis, it is not restored to a normal level. Gafter *et al*. [33] concluded that although dialysis may have some temporary beneficial effect, the long-term effect is not assured. The plausible 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 [26,27,34].

Our study revealed that 27.1% of the patients showed no change in the hearing threshold at the end of the study, 8.5% showed improvement, and the majority (64.4%) exhibited deterioration.

In agreement with many studies [5,8,19], hearing loss among patients in this study was dominant in the higher frequencies.

High blood urea and electrolyte disturbances, particularly sodium, have been suggested as possible factors that contribute to hearing acuity deterioration in CRF [2,35]. In contrast, our study showed no relation between the levels of blood urea, creatinine, serum potassium, serum calcium, and serum sodium and hearing loss. This is in agreement with the results reported by Agarwal [8] and Reddy *et al*. [17]

In accordance with Somashekara *et al*. [36], the duration of hemodialysis and CRF was significantly longer in patients with hearing loss.

The prevalence of hearing loss was lower in patients on three sessions of dialysis/week than in those on two sessions/week. However, the association was not significant. This result is similar to that reported by Jamaldeen *et al*. [3]

Multivariate analysis showed that the duration of dialysis was the only independent predictor of hearing loss. It was able to explain 51.5% of variation in the hearing threshold. This result is similar to that reported by Renda *et al*. [14]

Although our results are interesting and in line with previously published results, they should be interpreted with caution because of the small sample size and absence of a control group, such as patients on conservative treatment or healthy controls.

Conclusion

SNHL is common in patients with CRF on hemodialysis. The duration of dialysis has a significant adverse effect on the hearing threshold.

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Conflicts of interest

There are no conflicts of interest.

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