

Evaluating the Prevalence of Sensorineural Hearing Loss in Chronic Renal Failure Patients Undergoing Hemodialysis in Imam Khomeini Hospital, Ahvaz, 2012-2014

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End Stage Renal Disease (ESRD) is a main and serious cause of disability and mortality in developed societies. This debilitating condition affects many aspects of the patients' life, among which sensorineural hearing loss can be mentioned as one of the notorious side effects of renal failure. There are reasons which can justify the higher rate of hearing loss in these patients; from which the anatomical, physiological, pharmacological and pathological similarities between nephrons and the structure of cochlea is of great notion. Thus, this study was conducted based on the purpose of determining the prevalence of sensorineural hearing loss in ESRD patients undergoing hemodialysis in Imam khomeini Hospital, Ahvaz, Iran. Considering the inclusion criteria of the study, 58 patients under hemodialysis therapy were assigned to the study. Firstly, to assure the health of tympanic membrane, otoscopy was performed for all of the patients. After otoscopy examination, a tympanometry test (Type B tympanometry) was also done. Those, whom this test was performed for, if both ears proved afflicted by conductive hearing loss, were excluded from the study. For the remaining cases, pure tone audiometry and speech tests including Speech Discrimination Score (SDS) and Dynamic Range (DR) were carried out and the obtained data were summarized by descriptive statistics (frequency and percentage) in different age groups, frequency of auditory waves, gender, and duration of dialysis. From the 58 patients participating in this study, 53 patients (91.4%) had sensorineural hearing loss, 14 cases unilaterally and the other 39 bilaterally. The results for the prevalence of hearing loss were 71% for high frequencies (4-8 KHz), 36.8 % for moderate frequencies (1-2 KHz) and 54.3 % for low frequencies (0.25-0.5 KHz). 36 of evaluated patients (31.5%) represented with hearing loss in all the 3 categories of frequencies. The rate of patients with abnormal DR results was considerably high (32.7%). This study also demonstrated an uprising trend in correlation with age and hearing impairment seems to have no correlation with gender and the duration of hemodialysis therapy. It was also shown that high and low frequencies are affected more severely by the pathologic process of the hearing loss. This study has demonstrated that the sensorineural hearing loss was of high prevalence (91.4%) among the chronic renal failure patients, under hemodialysis treatment. therefore, some facilities should be considered in CRF patients in order to prevent such progressive complications. Although further studies are needed to show more evidence in this case.

Key words: Sensory neural hearing loss, Chronic renal failure, Hemodialysis, End stage renal disease.

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Chronic renal failure (CRF), as the end stage of disease, is a severe systemic impairment which not only leads to the imbalance of water and electrolytes, but also impairs other organs, directly or indirectly¹. The many progresses in approaching to CRF patients, has brought about a significant increase in their Life Expectancy and thus lead to manifestation of late onset problems of other organs more than before². One of these organs is otovestibular system. Anatomical, physiological, pharmacological and pathological similarities between the structure of nephrons and inner ear justify the accompaniment of ESRD (End Stage Renal Disease) and hearing loss. Hearing loss brings along social and financial complications. Due to negative impact on many of the individual's abilities to adapt to the environment, such condition is considered a major communication handicap. Hearing loss can be categorized into five groups: conductive hearing loss, sensorineural hearing loss, mixed hearing loss, central auditory hearing loss and non-organic hearing loss. In ESRD patients who are under hemodialysis therapy, the most common type is sensorineural hearing loss. This type of hearing loss occurs when the sensory organ of hearing (cochlear hair cells) or auditory nerve fibers are damaged³. In previous studies, the incidence of sensorineural hearing loss in hemodialysis patients has been reported within a range of 25% to 75%. The Precise mechanism of hearing loss that occurs in patients with renal failure is not clear yet. Metabolic disorders such as uremic toxins accumulation, endocrine disorders or osmotic shift are thought to be associated with hearing loss in these patients. Another explanation for the hearing decline can be the consumption of ototoxic drugs such as diuretics and antibiotics, anemia, infections, hemodynamic changes following hemodialysis, hypertension disease, diabetes, and small-vessel disease in most of these patients⁴. Hearing disorders can be divided into different degrees of severity. 20 to 40 dB hearing loss can be considered as mild hearing loss, 40 to 60 dB as moderate, 60 to 80 dB as severe and finally greater than 80 dB means profound hearing loss. Most people referring to hearing clinics have difficulty understanding speech. Therefore, it is important to assess speech hearing tests and speech thresholds, which is not only useful for

determining the location of the lesion, but also to select appropriate rehabilitation therapies. Speech audiometry tests measure Speech Discrimination Score (SDS) and Dynamic Range (DR). This study was conducted based on the purpose of determining the prevalence of sensorineural hearing loss in ESRD patients undergoing hemodialysis in Imam Hospital, Ahvaz.

MATERIALS AND METHODS

In this study, the cases were selected among a non-random sample of 120 patients with chronic kidney disease under hemodialysis treatment at Imam Hospital, Ahvaz, Iran, from 1st April 2012 to March 1st 2014. Among the 120 patients whose names were on the list, 3 patients had already expired, 7 patients had gone to other centers and 13 of them did not consent to participate in the study. 15 patients were not eligible for the study and thus excluded. The exclusion criteria consisted of transplantation history, history of frequent ear infections, dialysis for less than 3 months, experience of noisy occupations, history of physical ear damage, and congenital deafness or hearing loss. Data collection sheets were filled out for participants. In each sheet, data on gender, age, duration of dialysis, cause of renal failure, medications, Speech – Discrimination Score (SDS), and Dynamic Range (DR) was collected. Eventually, a total of 58 patients attended for physical examination; an otoscopy in order to ensure the health of tympanic membrane, in addition to a descriptive history. Tympanometry test was also assessed after otoscopy for all patients. In this study, the criterion for differentiation of hearing loss was as much as 20 dB. The severity of hearing loss was graded into 4 groups of mild (20 - 40 dB), moderate (40- 60 dB), severe (60 - 80 dB) and profound (above 80 dB). Frequencies were divided into three categories: High (4 - 8 KHz), moderate (1 - 2 KHz) and low (0.25 - 0.5 KHz). Speech tests including Speech Discrimination Score (SDS) and Dynamic Range (DR) were carried out. Finally, the obtained data were summarized by descriptive statistics (frequency and percentage). In addition, CHI-Square was used in order to compare the mean differences regarding the measured frequencies.

All the statistical analyses were performed through the SPSS statistical software (v. 17.0) and $p < 0.05$ was considered as statistically significant.

RESULTS

58 patients, 34 men (58.6%) and 24 women (41.3%), participated in this study. Two right ears were excluded and therefore 56 right ears and 58 left ears were assayed. The average age of the cases was 45.3 ± 1.3 (14 – 72). The average duration of hemodialysis treatment was 34.2 months (3 – 120).

Assessing the prevalence of hearing loss, 8.6% of total 58 subjects had normal hearing (N=5) and 91.4% (N=53) suffered from hearing loss. Among those afflicted with hearing loss, 39.6% (N=21) were female and 60.4% (N=32) were male. Among the 114 evaluated ears, 54.3% (N=62) in low frequencies, 36.8% (N=42) in moderate frequencies and 71% (N=81) in high frequencies presented with hearing loss. 31.5% of all ears, including 17 left ears and 19 right ears, showed hearing loss in all frequencies. 90% of those treated for less than 10 months had hearing loss (N=9 out of 10). 87.5% for those between 11 to 30 months (N=21 out of 24), 100% between 31 to 60 months

(N=16 out of 16) and finally 87.5% (N= 7 out of 8) for those under more than 60 months of dialysis.

Dynamic Range of patients was evaluated through UCL-SRT formula, proving 67.2% (N=39) normal and 32.7% (N=19) abnormal (Table 1). Speech discrimination score was normal for 94.8% (N=55) and abnormal for 5.1% (N=3) (Table 2).

To evaluate hearing loss based on the age, patients were divided into 7 age groups. In the first group (10 – 20 year) 50%; in the second group (21- 30 year) 66.6%; in the third group (31-40 year) 68.1%; in the fourth group (41 – 50 year) 75%; in the fifth group (51 – 60 year) 94.1%; in the sixth group (61-70 year) 90% and finally in the seventh group (more than 70 year) 100% of patients were afflicted with hearing loss. More detailed data is shown on Table 3.

Concerning different frequencies, of the total 114 ears assessed, 31.5% (N=61) in frequency of 250 Hz; 31.5% (N=36) in frequency of 500 Hz; 28.9% (N=33) in frequency of 1000 Hz; 32.4% (N=37) in frequency of 2000 Hz; 56.1% (N=64) in frequency of 4000 Hz; 64.9% (N=74) in frequency of 6000 Hz and 69% (N=79) in frequency of 8000 Hz had hearing loss. More detailed data is showed on Table 4.

Table 1. DR of right and left ear

DR	No.	Right ear	Left ear
Abnormal	39(67.2%)	15	16
Normal	19(32.7%)	41	42
Total	58	56	58

Table 2. SDS of right and left ear

SDS	Right ear	Left ear
Normal	53	55
Mildly low	2	1
Moderately low	1	2
Low	-	-
Very low	-	-

Table 3. The prevalence of impaired hearing ability in patients undergoing dialysis by age groups

Age Group	Prevalence in age group	Prevalence of hearing impairment (by ear)	Percentage of hearing impairment in each age group	Right ear				Left ear			
				normal	Low	high	all	normal	Low	high	All
10-20	2	2	50%	-	1	-	1	-	1	-	1
21-30	9	12	66.6%	2	5	-	2	2	-	3	4
31-40	11	15	68.1%	3	2	1	5	5	1	3	1
41-50	12	18	75%	3	5	-	4	6	3	1	2
51-60	17	32	94.1%	12	3	1	1	14	1	1	1
61-70	5	9	90%	4	1	-	-	4	-	-	-
71-80	2	4	100%	1	1	-	-	1	1	-	-
Total	58	92	80.7%	25	18	2	13	32	7	8	9

Table 4. The prevalence of impaired hearing ability in patients undergoing dialysis by frequency of auditory waves

Frequency of auditory wave	Right ear (per 56)	Left ear (per 58)	Right ear				Left ear			
			mild	moderate	severe	profound	mild	moderate	severe	Profound
250	40(71.4%)	21(36.2%)	37	2	1	0	17	2	1	1
500	21(37.5%)	15(25.8%)	17	3	1	0	10	3	1	1
1000	13(23.2%)	20(34.4%)	7	4	2	0	13	6	1	0
Low frequency	74+	56+	61+	9+	4+	0	40+	11+	3+	2+
2000	18(32.1%)	19(32.7%)	10	6	0	2	11	4	4	0
4000	31(55.3%)	33(56.8%)	19	5	4	3	16	12	2	1
6000	36(64.2%)	38(65.5%)	15	11	5	5	13	16	4	5
8000	38(67.8%)	41(70.6%)	10	13	5	10	12	14	7	8
High frequency	123+	131+	54+	35+	14+	20+	52+	46+	17+	14+

DISCUSSION

Hearing loss involves a great proportion of CRF patients and the incidence of sensorineural hearing loss is dramatically higher in these patients compared to normal population⁵. In this study, we observed that the prevalence of sensorineural hearing loss was 91.4% in dialysis patients of Imam Hospital, Ahvaz. This hearing loss seems to be independent of gender and dialysis duration. On the other hand, it shows an uprising trend in correlation with age; yet, it doesn't show if it's correlated with age or is merely the effect of dialysis. The rate of hearing loss was greatest in higher frequencies and lowest in moderate ones. The rate of patients with abnormal DR results was considerably high (32.7%) that shows the necessity of recruitment tests in these patients. SDS was not influenced in ESRD patients. Considering the rate of hearing loss for specific frequencies, 250 Hz is significantly high, and then it declines until 1000 Hz and rises again to a maximum of 69.2% at 8000 Hz. 1000 Hz was the least and 8000 Hz was the most affected frequencies. The pathologic etiology of hearing loss in CRF patients is not yet clearly known and even controversial theories have been suggested. In a case report by Risvi and Holmes, a severe hearing loss in a dialysis patient was observed. Anatomical changes in labyrinth, such as endolymphatic collapse, edema and atrophy was recognized⁶. In a study designed to evaluate bone density of otic capsule in CRF patients, the association osseous remodeling of the otic capsule and loss of bone density with Hearing loss was

noticed⁷. It's been suggested that changes in serum osmolality, BUN and fluid retention after dialysis can reverse the process of hearing loss, as they have reported an improvement of 20 dB in patients⁸. Gatland et al. applied pure tone audiometry on 31 patients before and after one dialysis session and noticed an improvement in 1/3 of patients in low frequencies⁹. In a study conducted on hemodialysis CRF children aged 10 – 18 years, subclinical problems in conduction was noticed but the condition was improved after uremic toxins and hyperkalemia were removed. Seemingly, uremic axonopathy is responsible for this hearing impairment¹⁰. The mechanism of axonopathy is in coordination with neurocognitive dysfunctions detected in CRF patients which normally tend to get better after renal transplantation¹¹. Still, some studies believe that the electrolyte and biochemical content of serum do not correctly show the audiologic status of a CRF patient⁵. Hearing loss in CRF patients presents with a variety of audiologic patterns⁵. In a study, among the total patients with CRF, 60% presented with hearing loss, 36% with vestibular abnormalities, and 26% with combined¹². Due to the rapidity of considerable changes in electrolyte concentration in the process of hemodialysis, some believe this method is disturbing¹⁰ but others argue that hemodialysis may not have any influences on hearing⁵. It is also stated that the sensorineural hearing loss in patients undergoing hemodialysis may be attributed to the preexisting renal disease¹³. Unfortunately, End Stage Renal Disease (ESRD) is a main and serious cause of disability and mortality in developed

societies. This debilitating condition affects many aspects of the patients' life¹. It is hoped that based on the data of this study and upcoming researches correlated to this concept, some effective solutions will be suggested in order to prevent such events.

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