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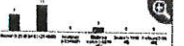
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Characteristics of Hearing Loss in Patients with Chronic Kidney Disease Undergoing Hemodialysis

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Abstract

Background: Hearing loss in chronic kidney disease (CKD) patients undergoing hemodialysis (HD) is sensorineural and bilateral and occurs at high or low frequencies. Hearing loss in HD is caused by osmotic disorders, changes in fluid and electrolytes in the cochlea's endolymph, and possible exposure to membrane dialyzer. **Objective:** The objective of this study is to explain the characteristics of hearing loss in patients with CKD undergoing HD. **Methods:** This was a descriptive research using the secondary data from 20 ears in 10 CKD patients undergoing HD at the Airlangga University Hospital in September–October 2018. **Results:** Sensorineural hearing loss in 13 of 20 ears (65%) and bilateral in 6 pairs of ears (85.7%). The highest degree of hearing loss was mild in 11 of 20 ears (55%). The average hearing threshold is 32.1 dB. The average hearing threshold for each frequency is dome shaped. The highest average hearing threshold at a frequency of 8000 Hz is 44 dB. The refer results of DPOAE in 17 of the 20 ears (85%) refer result in four patients without hearing loss. The most refer results of DPOAE are obtained at a frequency of 4000 Hz. **Conclusion:** The most characteristic hearing loss is sensorineural, bilateral, and mild hearing threshold. The average hearing threshold graph forms a dome-shaped image that illustrates the hearing loss that can occur at high and low frequencies.

Keywords: Audiometry, chronic kidney disease, distortion-product otoacoustic emission, hemodialysis, sensorineural hearing loss

INTRODUCTION

Hearing loss in patients with chronic kidney disease (CKD) undergoing hemodialysis (HD) is sensorineural, symmetrical, and bilateral.^[1] Sensorineural hearing loss is a decrease in hearing acuity caused by the lesions in the cochlea and or VIII nerve. Hearing loss in CKD undergoing HD can occur at both high and low frequencies.^[2] Low-frequency hearing loss is related to endolymphatic hydrops and is associated with the changes in fluid composition and endolymph electrolytes during HD.^[1,2] Several risk factors can affect hearing function in CKD patients undergoing HD include hypertension, type 2 diabetes mellitus (DM), and the use of diuretic drugs.^[3] This study aims to explain the characteristics of hearing loss in patients with CKD undergoing HD at the Airlangga University Hospital in Surabaya.


METHODS

Descriptive research uses secondary data from 20 ears in 10 patients with CKD undergoing HD at the Airlangga

University Hospital in September–October 2018. The research sample is the data that fits the inclusion and exclusion criteria. The inclusion criteria are patients aged 21–60 years. The exclusion criteria were a history of ear disease and trauma, exposure to noise, otoscopy examination found abnormalities in the outer and middle ear, and audiometry obtained by the conduction and mixed hearing loss. The hearing examination is carried out in a soundproof room of a maximum of 40 dB, which has been measured by a sound level meter (sound pressure level), with a minimum area of 1 m × 1 m. Inspection using Audx Pro brand DPOAE made in the USA in 2006 and the GSI Arrow audiometer. The operational definition of sensorineural hearing loss is a decrease in hearing acuity in one or two ears where the hearing threshold is above 25 dB and the results of air conduction and bone conduction

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coincide at frequencies from 250 to 8000 Hz. CKD is kidney damage or a decrease in glomerular filtration rate (GFR) of <60 mL/min/1.73 m² for a minimum of 3 months based on the diagnosis of an Internal Medicine Specialist (Nephrological Consultant). HD is a blood-cleansing procedure through an artificial kidney by a machine and is one of the therapies for Stage V CKD patients with a GFR of <15 mL/min/1.73 m².

RESULTS

Sensorineural hearing loss occurs in 13 of 20 ears (65%). Normal hearing is found in seven ears (35%). The youngest is 41 years old, and the oldest is 60 years old. The average age of patients with hearing loss is 56.2 years. The ratio of male and female patients with hearing loss does not differ much that is 1.2:1. Hearing loss often occurs in patients with accompanying hypertension accompanied by type 2 DM, namely nine ears (45%). Hearing loss was experienced by seven ears (35%) of CKD undergoing HD and consumed furosemide. HD is done twice every week. The average duration of HD is 4.85 months. The longest HD duration is 8 months, and the fastest is 1 month. The group with the highest duration of HD with hearing loss is a range of 2–6 months, namely seven ears (35%). There were no CKD patients undergoing HD for more than 12 months in this study [Table 1].

Based on the data shown in Table 1, patients with hearing loss constituted the majority of the study population (56–60 months' age group) with 8 patients (40%), followed by the age group of 51–55 months with 5 patients (25%), and there were no one patients in the age group of 46–50 years and 41–45 years who have hearing disorder.

Distribution data based on gender in Table 2, patients with CKD undergoing HD had hearing disorder in 6 females (30%) while males as many as 7 patients (35%).

Based on the data in Table 3, 2 (10%) CKD patients without concomitant disease had hearing loss, whereas 2 (10%) CKD patients with type 2 DM and 9 (45%) CKD patients with hypertension and type 2 DM had hearing loss. No CKD patients with hypertension had hearing loss.

Distribution data based on the table 4, showed that 7 patients (35%) who consumed diuretic medicine had hearing loss, whereas 6 patients (30%) who did not consume diuretic medicine had hearing loss.

Based on the data in Table 5, patients with duration of HD for less than a month had hearing loss were 2 patients (10%), patients with 2–6 months duration of HD as many as 7 patients (35%), and patients with more than 6 months' duration of HD as many as 4 patients (20%).

Bilateral sensorineural hearing loss occurs in 6 of 7 pairs of ears (85.7%). One pair of ears has unilateral sensorineural hearing loss, one side has a normal hearing threshold, and the contralateral side has a mild hearing loss. The average hearing threshold for CKD patients under HD is 32.1 dB. The highest degree of

Table 1: Distribution of age patients

Age (years)	Hearing disorders (%)		Total ears (%)
	Yes	No	
41–45	0 (0)	2 (10)	2 (10)
46–50	0 (0)	0 (0)	0 (0)
51–55	5 (25)	5 (25)	10 (50)
56–60	8 (40)	0 (0)	8 (40)

Table 2: Distribution of gender

Gender	Hearing disorder (%)		Total (%)
	Yes	No	
Male	7 (35)	1 (5)	8 (40)
Female	6 (30)	6 (30)	12 (60)

Table 3: Distribution of concomitant systemic disease

Concomitant systemic disease	Hearing disorder (%)		Total (%)
	Yes	No	
None	2 (10)	2 (10)	4 (20)
Hypertension	0 (0)	0 (0)	0 (0)
Type 2 DM	2 (10)	0 (0)	2 (10)
Hypertension and type 2 DM	9 (45)	5 (25)	14 (70)

DM: Diabetes mellitus

Table 4: Distribution of diuretic medicine

Diuretic medicine	Hearing disorder (%)		Total (%)
	Yes	No	
Yes	7 (35)	1 (5)	8 (40)
No	6 (30)	6 (30)	12 (60)

Table 5: Distribution of duration of hemodialysis (month)

Duration of HD (months)	Hearing disorder (%)		Total (%)
	Yes	No	
<1	2 (10)	2 (10)	4 (20)
2–6	7 (35)	5 (25)	12 (60)
>6	4 (20)	0 (0)	4 (20)

hearing loss was mild in 11 of 20 ears (55%). Severe moderate degree occurs in 2 of the 20 ears (10%). In this study, there was no moderate, severe, and very severe hearing loss [Figure 1].

The average hearing threshold is calculated at each frequency of 250–8000 Hz. The highest average hearing threshold at 8000 Hz frequency is 44 dB. The lowest average hearing threshold at 2000 Hz is 26.5 dB [Figure 2]. The DPOAE results use pass or refer grading criteria at frequencies of 1000–10,000 Hz. DPOAE refer results were obtained in 17 of the 20 ears (85%); four refer results were experienced without hearing loss. The results of DPOAE on each frequency of 1000–10,000 Hz are calculated by the number of pass and refer events. The most DPOAE refer results were obtained at a frequency of 4000 Hz for 19 events.

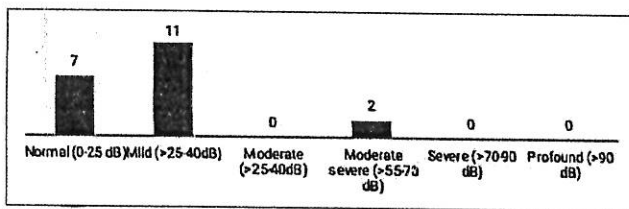


Figure 1: Degree of hearing threshold

DISCUSSIONS

Audiometry results in 13 ears (35%) of patients with CKD undergoing HD obtained sensorineural hearing loss. This type of hearing loss is used to identify the location of lesions in the outer, middle, or inner ear.^[4] Sensorineural hearing loss due to HD can be caused by osmotic disorders, resulting in loss of hair cells, collapse of the endolymph space, edema and supporting cell atrophy, fluid and electrolyte changes endolymph in the cochlea, and possible exposure to cellulose acetate membrane from the used dialyzer.^[3] In another study in Iraq, there was a 66.1% sensorineural hearing loss, and the prevalence increased to 76.3%, with an incidence of 30% after 12 months.^[5]

The average age of patients with hearing loss is 56.2 years. In a research in Iraq, the average age of 53 years was obtained with a range of 17 until 60 years. This mean age is significant with the incidence of hearing loss in patients with CKD performed HD in the study.^[5] Hearing loss mostly occurs in patients with hypertension accompanied by type 2 DM, namely nine ears (45%). Prolonged hypertension can result in changes in the structure of arterioles throughout the body.^[6] DM causes microangiopathy in the cochlea, resulting in atrophy and reduction of hair cells.^[6] In a Brazilian study, a significant association with hypertension was found with the incidence of hearing loss in patients with CKD undergoing HD.^[7] Hearing loss experienced by seven ears (35%) of patients taking furosemide in this study. Furosemide will inhibit ion transporters in the loop of Henle from the kidney whose isoform is also present in the epithelial stria vascular.^[6] Fifty percent of sensorineural hearing loss is reported in CKD with HD that consumes long-term furosemide.^[2] The average duration of HD that has been taken is 4.85 months. The HD duration group 2–6 months had the most hearing loss, namely seven ears (35%). In a study in Iraq, there was a significant relationship between the duration of HD over 12 months and the incidence of hearing loss.^[5] The duration of HD can affect the incidence of hearing loss in patients with CKD undergoing HD but needs further research.

The degree of hearing loss is assessed based on the International Organization for Standardization. Bilateral sensorineural hearing loss occurs in 6 of 7 ear pairs (85.7%). The highest degree of hearing loss was mild in 11 of 20 ears (55%). The average hearing threshold for CKD patients undergoing HD is 32.1 dB. The highest average hearing threshold at a frequency of 8000 Hz is 44 dB. The highest degree of hearing loss in patients with CKD undergoing HD is a mild degree.^[8] The incidence of hearing loss in patients with CKD undergoing HD is mostly found at high frequencies of 77.14%.^[9] The

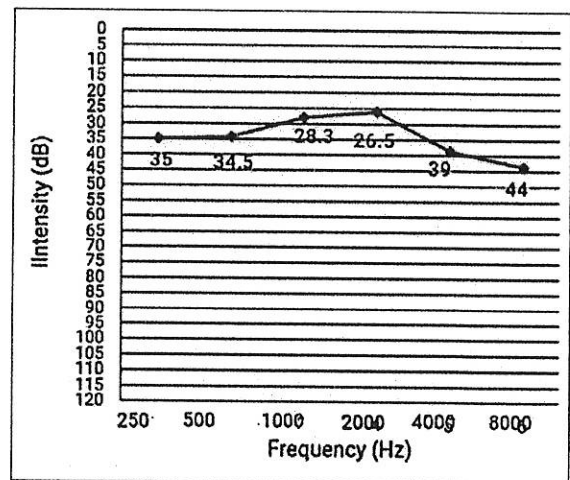


Figure 2: Average hearing threshold at each frequency

increased hearing threshold at speech frequency is only 17%.^[7] The degree of interference hearing in other studies showed a mild degree of 46%, a moderate degree of 7%, and a moderate–severe degree of 0.5%, and there were no patients with severe and very severe hearing loss.^[3] The mean hearing threshold for each frequency in this study was in the form of a dome-shaped curve, showing the incidence of hearing loss occurs at low and high frequencies.

In the four ears, DPOAE refer results were obtained, even though the audiometry had not shown any hearing loss. The most DPOAE refer results are obtained at a frequency of 4000 Hz. DPOAE examination is more sensitive in checking cochlear function so that it can be used for screening.^[10] A reduction in cochlear emissions in patients with CKD undergoing HD before hearing threshold changes may indicate a pathological condition in the cochlea.^[10] The results of DPOAE examination are influenced by middle ear conditions, and hence ideally, tympanometry is performed first. Tympanometry was not carried out in this study due to device limitations.

CONCLUSION

The characteristics of hearing loss in patients with CKD undergoing HD in this study were sensorineural, bilateral, and mild hearing threshold. The average hearing threshold graph forms a dome shaped that illustrates hearing loss can occur at high and low frequencies. Some ears already have disturbances in the cochlea before there is a worsening of the hearing threshold.

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Conflicts of interest

There are no conflicts of interest.

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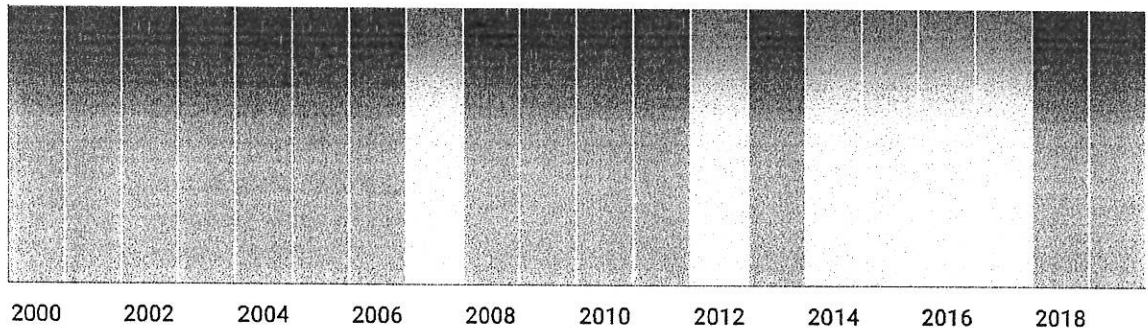
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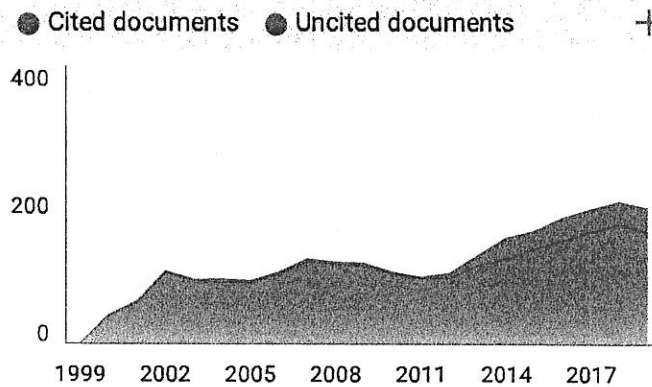
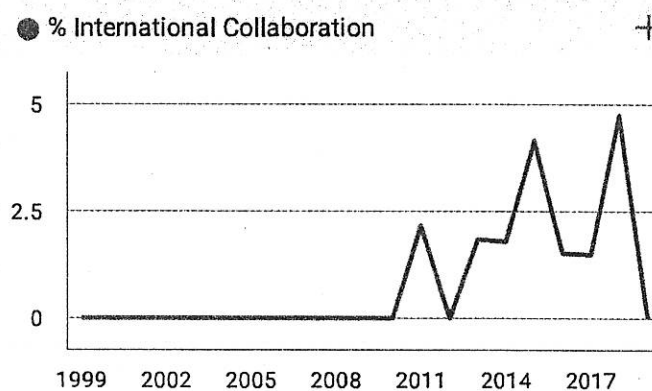
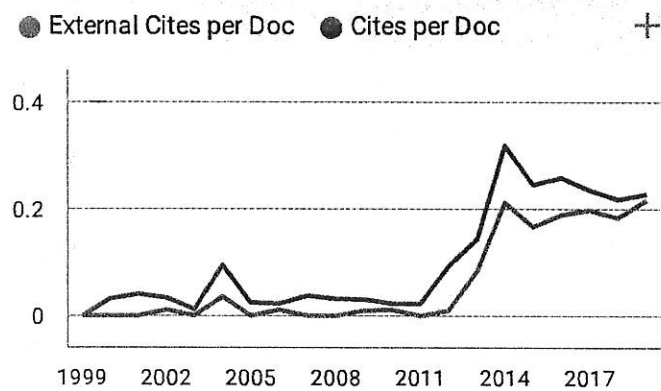
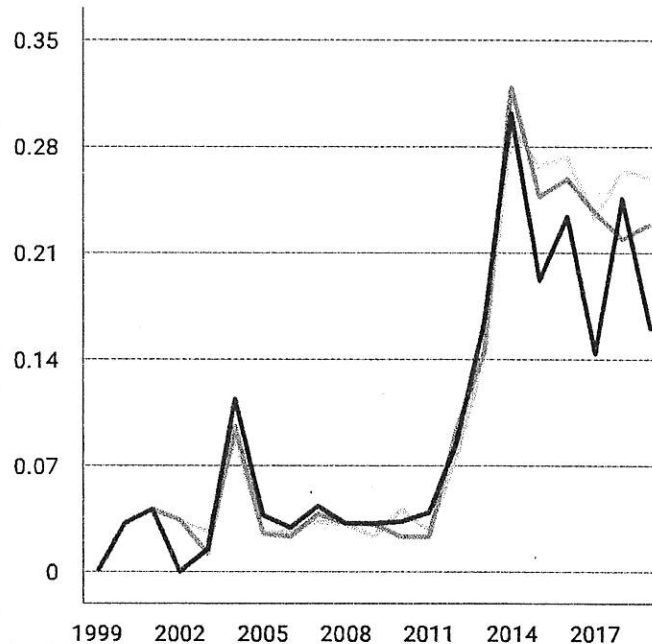
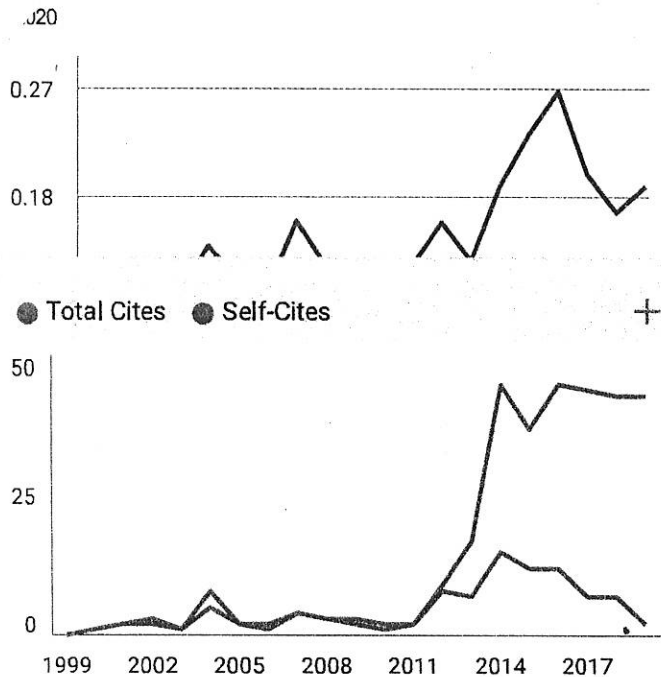
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