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The Relationship Between Hemodialysis And High-Frequency Hearing Loss In Chronic Kidney Disease Patients At Dr. Wahidin Sudirohusodo General Hospital, Makassar

Yudi L. Syafii[*1], Abdul Kadir[1], Trining Dyah[1], Abdul Salam[2]

[1*]Department of Otorhinolaryngology – Head and Neck Surgery, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia

[2]Department of Nutrition Science, Faculty of Public Health, Hasanuddin University, Makassar, Indonesia

***Corresponding Author**:

Yudi L. Syafii,

Department of Otorhinolaryngology – Head and Neck Surgery, Faculty of Medicine, Hasanuddin University; Perintis Kemerdekaan, Tamalanrea Jaya, Tamalanrea, Makassar, South Sulawesi, 90245, Indonesia.

Email ID: yudi_syafii@dr.com

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ABSTRACT

Background: In patients with chronic kidney disease (CKD), nephron damage leads to reduced kidney excretory function, resulting in toxin accumulation, electrolyte disturbances, metabolic acidosis, and calcium metabolism disorders, all of which may affect the cationic gradient in the cochlea and disrupt auditory function.

Aim: To determine the relationship between hemodialysis and highfrequency hearing loss in CKD patients at Dr. Wahidin Sudirohusodo General Hospital.

Methods: A cross-sectional study involving 40 CKD subjects, with a distribution of non-hemodialysis CKD patients (n=20) and hemodialysis patients (n=20), conducted at Wahidin Sudirohusodo Hospital Makassar from January to December 2024. ENT examination and audiometry tests were performed to assess hearing thresholds.

Results: The degree of hearing loss in the right ear was significantly found at 6000 Hz with an average threshold of 39.75 ± 14 dB, and at 8000 Hz with an average threshold of 47.5 ± 12.9 dB. In the left ear, it was also significant at 6000 Hz with an average threshold of 43 ± 13.51 dB, and at 8000 Hz with an average threshold of 49 ± 19.3 dB in the hemodialysis group. There is a relationship between hemodialysis and high-frequency hearing loss. Age, gender, and comorbid characteristics were not associated with hemodialysis status.

Conclusion: There is a relationship between hemodialysis and high-frequency hearing loss, especially at 6000 and 8000 Hz

Keywords: *hemodialysis, hearing impairment, high frequency, chronic kidney disease, audiometry.*.

1. INTRODUCTION

The issue of hearing loss has been a global phenomenon, affecting various individuals around the world. According to data compiled by the World Health Organization (WHO), approximately 360 million individuals experienced some degree of hearing loss in 2008. In 2018, the figure increased to over 466 million globally, with South Asia hosting the highest concentration of affected patients. In addition, 630 million individuals are expected to experience some degree of hearing loss by 2030, and this figure has been projected to increase by 2050.[1,2]

According to previous studies, hemodialysis is a process that comprises filtering blood with the use of a machine called a dialyser, which is similar to an artificial kidney. This process has been reported to reduce hearing threshold, BUN, and fluid retention due to changes in serum osmolarity. Increased osmolality can cause the endolymphatic space to collapse and reduce the edema of some functionally active auditory cells.[3,4]

Saeed et al. (2018) reported that SNHL is common in chronic kidney disease (CKD) patients undergoing hemodialysis (64.4%), with symptoms ranging from mild to moderate in most patients. Hearing loss has also been shown to be more evident in the high frequencies.[5] Vajushi et al. (2022) showed that there was no significant relationship between hemodialysis

and hearing loss in CKD patients.[6] However, Kumar et al. (2022) reported that it played a significant role in the SNHL process in CKD patients. Despite the existing literature, there is no proof linking hemodialysis to SNHL. Consequently, patients with CKD must have audiological evaluations and otological examinations before beginning hemodialysis treatment.[7]

Several hypotheses have been made on the structural, physiological, immunological, and pharmacological similarities between the human kidney and the cochlea. Similar to the kidney, the cochlea uses the stria vascularis and glomerulus to actively transport fluids and electrolytes.[8] The cationic gradient in the cochlea can be impacted by nephron destruction in CKD, which causes various complications. These include a loss in renal excretory function, toxic buildup, electrolyte imbalances, metabolic acidosis, and problems of calcium metabolism, thereby impeding hearing performance.[3,9]

Although several studies have shown a solid correlation between hemodialysis and hearing loss in CKD patients, the exact nature of this relationship is unknown.[5,6] Studies on this relationship are also limited in Makassar, prompting interest in exploring the relationship between hemodialysis and hearing loss in CKD patients. When the results show a significant relationship, early ear examinations could be implemented as a screening tool for hearing loss in hemodialysis patients, thereby facilitating timely diagnosis and intervention

2. MATERIALS AND METHODS

This observational analytical study was conducted at Dr. Wahidin Sudirohusodo General Hospital from July 2024 to December 2024, and aimed to examine the association between hemodialysis and high-frequency hearing loss in patients with CKD. A cross-sectional design was used, with data collected once from each participant using purposive sampling. The study comprised 40 participants, consisting of 20 hemodialysis and 20 non-hemodialysis patients.

The study variables included hemodialysis status as the independent variable, high-frequency hearing threshold as the dependent variable, and gender, presence of comorbidities, and age of respondents as confounding variables.

The relationship between hemodialysis status and hearing thresholds in the right and left ears was analyzed. In this study, the frequencies tested included 250Hz, 500Hz, 1000Hz, 2000Hz, 3000Hz, 4000Hz, 6000Hz, and 8000Hz. The average difference in hearing threshold at these frequencies between hemodialysis and non-hemodialysis groups was analyzed using the Mann-Whitney test. The study protocol was reviewed and approved by the Health StuDY Ethics Committee of Universitas Hasanuddin (Ethical Approval No. 331/UN4.6.4.5.31/PP36/2024) on January 12, 2024, in compliance with institutional and national ethical guidelines.

3. RESULTS

Participants Characteristics

Data were collected from patients with CKD undergoing hemodialysis at Dr. Wahidin Sudirohusodo General Hospital from July to December 2024. The characteristics of participants were presented in Table 1.

Table 1.Participants Characteristics

Variables		n (%)
Group	Hemodialysis	20 (50.0%)
	Non-Hemodialysis	20 (50.0%)
Gender	Male	18 (45.0%)
	Female	22 (55.0%)
Comorbid	Yes	33 (82.5%)
	No	7 (17.5%)
Age (years)	<30	7 (17.5%)
	30-60	25 (62.5%)
	>60	8 (20.0%)

This study enrolled a total of 40 participants, equally divided into 2 groups, namely 20 patients with hemodialysis and 20

non-hemodialysis patients. A total of 18 (45%) were male and 22 (55%) were female. No statistically significant difference in gender distribution was observed between the 2 groups. Regarding comorbidities, 33 participants (82.5%) reported having at least 1 comorbid condition, while 7 participants (17.5%) reported none. In terms of age distribution, the majority of participants (62.5%) were between 30 and 60 years old, while 17.5% were younger than 30 years and 20.0% were older than 60 years.

Relationship between Hemodialysis Status and Hearing

The following were the results of the relationship test between hemodialysis status and hearing threshold at several frequencies in the right ear.

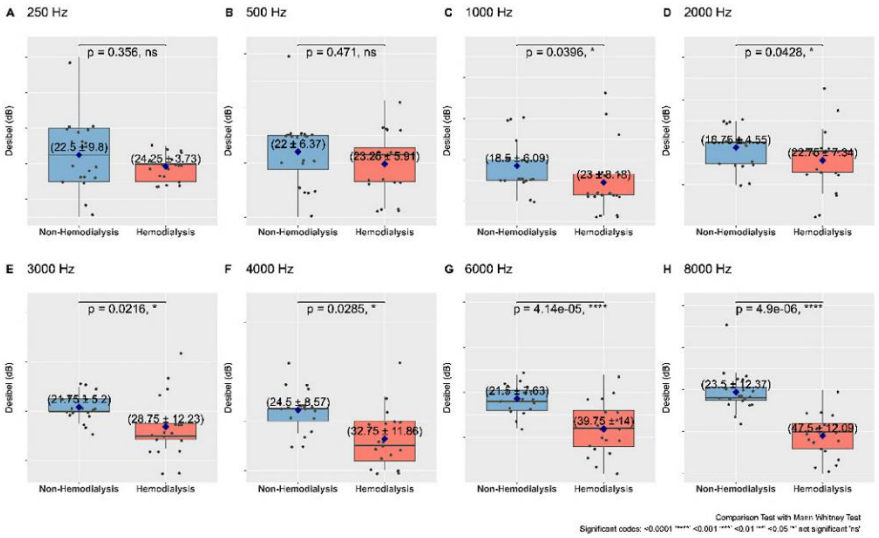

Figure 1. Relationship between Hemodialysis Status and Right Hearing.

At high frequencies (4000Hz, 6000Hz, and 8000Hz), the relationship between hemodialysis status and hearing threshold was stronger. Hemodialysis group had a worse average hearing threshold compared to the non-hemodialysis group, with a P<0.0285 at 4000Hz, 4.14e-05 at 6000Hz, and 4.9e-06 at 8000Hz (P<0.001). This indicated that hemodialysis status was associated with a decreased hearing threshold in the right ear, especially at high frequencies. The results revealed that hemodialysis patients had a greater risk of experiencing hearing loss at high frequencies than non-hemodialysis patients.

The following were the results of the test of the relationship between hemodialysis status and hearing threshold at several frequencies in the left ear.

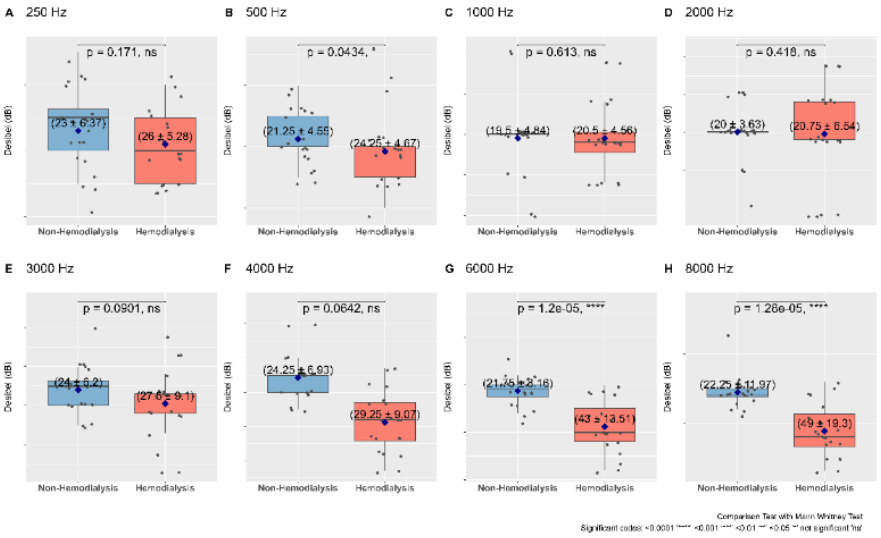

Figure 2 - Relationship between Hemodialysis Status and Left Hearing.

At high frequencies (6000Hz and 8000Hz), the relationship between hemodialysis status and hearing threshold was very significant. Meanwhile, at a frequency of 6000Hz, hemodialysis group had an average hearing threshold of 43±13.51dB, worse than the non-hemodialysis group (21.75±8.16dB), with a p-value of 1.2e-05 (P<0.001). Similar results were found at a frequency of 8000Hz, where hemodialysis group had an average of 49±19.3dB, higher than the non-hemodialysis group, which had an average of 22.25±11.97dB, with a p-value of 1.28e-05 (P<0.001).

At high frequencies (6000Hz and 8000Hz), there was a highly significant relationship, with patients undergoing hemodialysis having higher (worse) hearing thresholds. This result indicated that hemodialysis patients were at risk for hearing loss, specifically at high frequencies.

4. DISCUSSION

Based on these results, high-frequency hearing loss was more common in hemodialysis patients compared to non-hemodialysis individuals. Consistent with the results of Kumar et al. (2022), who investigated how hemodialysis affected the auditory system of CKD patients. Haemodialysis was shown to be significantly associated with hearing loss.[7] Sarin et al. (2022) analyzed high-frequency hearing loss in CKD, and the results revealed that there was a relationship between CKD patients undergoing hemodialysis and high-frequency hearing loss, namely at frequencies of 8000Hz, 9000Hz, 10,000Hz, and 11,200Hz (P<0.001 each).[10] According to Khavidaki et al. (2021), there was a significant relationship between hemodialysis and hearing loss (P<0.05).[11]

Hemodialysis could cause hearing loss, which was common in people with CKD. A debate about whether hemodialysis caused hearing loss or not occurred.[6,12] Inner ear dysfunction occurred due to harmful substances accumulating in the circulation due to impaired filtration caused by damaged kidneys, the body's most important organ for removing harmful chemicals.[13] In this study, there was evidence that the epithelium of the renal nephron and the cochlear duct were comparable. This suggested that both had ATPase-dependent sodium-potassium pumps. According to Khavidaki and Gharibi (2021), carbonic anhydrase was also found in the stria cochlea and nephron. Antibodies targeting the nephron were found in the stria vascularis, suggesting a possible immunological relationship between the kidney and the ear.[14,15] Compared with the general population who had age- and sex-matched hearing, the prevalence of cochlear hearing loss was higher in individuals with kidney disease.[11] Hypotension, electrolyte imbalance (specifically salt and water), vitamin D deficiency, and increased blood urea levels were some of the causes of hearing loss in patients with CKD. When the cationic gradient of endolymphatic fluid was defective, it had a detrimental effect on hearing. Peyvandi and Roozbahany (2013) as well as Saha and Mondal (2020) found that central and peripheral nervous system abnormalities, known as “uremic neuropathy,” could worsen hearing loss in CKD.[16,17]

To control the concentration of salts, minerals, and fluids in the blood, dialysis filtered the blood through a membrane and used a solution called dialysate. As with many medical procedures, dialysis caused a variety of adverse effects, including hearing loss.[18] In the time following hemodialysis, fluid retention increased in serum osmolarity and BUN, and other factors could lead to hearing loss. Some functionally active auditory cells could have had less swelling and the endolymphatic gap collapsed back into place when serum osmolality was higher. Therefore, hearing threshold was reduced, but only slightly.[17]

5. CONCLUSIONS

In conclusion, there was a relationship between hemodialysis and high-frequency hearing loss in the right and left ear, specifically at frequencies of 6000 and 8000 Hz.

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