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Original Research Article

Analysis of Future Hearing Thresholds in Chronic Kidney Disease Patients Undergoing Haemodialysis

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Abstract:

Background: Chronic kidney disease (CKD) significantly impacts various health aspects, including auditory functions. Haemodialysis, essential for CKD management, has been linked to complications extending beyond renal function deterioration, notably influencing hearing thresholds in patients. The study aims to examine the prospective changes in hearing thresholds among CKD patients undergoing haemodialysis to better understand haemodialysis 's impact on auditory function.

Methods: The prospective cross-sectional study was conducted at Sharda Hospital over two years, involving CKD patients undergoing haemodialysis and matched controls not on dialysis. We utilized pure-tone audiometry for audiological assessment, classifying hearing thresholds from normal to profound loss. Statistical analyses were achieved, with significance set at $p<0.05$.

Results: The study compared 60 participants divided into a haemodialysis group and a control group. The haemodialysis group, older on average (58.5 vs. 52.3 years), demonstrated significantly worse hearing outcomes compared to controls. Only 40% had normal hearing, versus 80% of controls, with 50% experiencing mild to moderate hearing loss, and 10% suffering severe impairments. Statistical analysis showed these differences to be significant ($p < 0.001$). There was a moderate correlation between longer haemodialysis duration and increased hearing loss severity ($r = 0.432$, $p = 0.011$). Additionally, poorer kidney function correlated with worse hearing outcomes ($r = -0.367$, $p = 0.032$), confirming that haemodialysis impacts auditory health significantly.

Conclusion: Haemodialysis is associated with a greater prevalence and severity of hearing loss in CKD patients. The correlation between the period of haemodialysis and hearing loss severity underscores the treatment's impact on auditory health.

Recommendations: Regular audiological assessments should be integrated into the management plans for CKD patients undertaking haemodialysis to facilitate early detection and management of hearing loss, potentially enhancing their quality of life.

Keywords: Chronic Kidney Disease, Haemodialysis, Hearing Loss, Audiometry, Kidney Function.

Introduction

Chronic kidney disease (CKD) and its management, particularly haemodialysis, present multifaceted challenges for patients, impacting various aspects of health including auditory functions. Haemodialysis, a lifesaving intervention for patients with CKD, has been associated with complications that extend beyond the kidneys, notably affecting the hearing thresholds of these patients [1].

Research indicates a significant correlation between CKD and hearing impairment, often characterized by sensorineural hearing loss (SNHL). Studies reveal that haemodialysis significantly elevates hearing thresholds in patients compared to those not undergoing dialysis, suggesting that the treatment itself may contribute to hearing deterioration [2]. Moreover, the severity and prevalence of hearing loss seem to raise with the duration of CKD and the number of haemodialysis sessions a patient undergoes.

The mechanisms behind hearing loss in CKD patients on haemodialysis are multifactorial. Osmotic alterations and biochemical imbalances due to kidney dysfunction and dialysis may disrupt the electrolytic balance within the cochlea, affecting the sensory cells crucial for hearing [3]. Research characterizes the typical hearing loss in this patient group as sensorineural and bilateral, often affecting both high and low frequencies, which aligns with the findings that the hearing loss pattern is influenced by the duration of the disease and treatment [4].

Periodic audiological assessments are recommended for CKD patients, especially those undergoing haemodialysis. Early detection and intervention could mitigate the progression of hearing loss and enhance the quality of life for these patients. The cumulative research suggests that while haemodialysis is essential for managing kidney failure, its impacts on hearing necessitate integrated care approaches that also address the auditory health of CKD patients.

The study aim was to prospectively analyze changes in hearing thresholds among patients diagnosed with CKD undergoing haemodialysis, with the objective of understanding the impact of haemodialysis on auditory function over time.

Methodology

Study Design: A prospective cross-sectional design was employed.

Study Setting: The study was conducted at Sharda Hospital, Greater Noida, UP-201310, a tertiary healthcare facility with a 314-bed capacity, serving as a referral center for medical and surgical services in the region. The hospital houses a nephrology unit and a dialysis center. The study spanned two years.

Participants: Patients diagnosed with CKD who were undergoing haemodialysis were enrolled. Patients with CKD who were not receiving dialysis and were selected from the hospital's nephrology unit based on age and sex. Using a convenience selection technique, consecutive patients who met the inclusion criteria and gave their informed consent and were at least 18 years old and attending the nephrology unit and dialysis centre during the study period were enrolled.

Inclusion and Exclusion Criteria: Patients with stage I and II kidney disorders, previous evidence of ear pathology, previously present hearing impairment prior to renal pathology, patients too sick to undergo audiometric testing, and individuals under the age of eighteen were among the exclusion criteria, whereas the inclusion criteria included CKD patients receiving haemodialysis.

Bias: To minimize bias, a control group matched for age and sex was included, and convenience sampling was utilized.

Variables: The variables studied included medical history, demographic characteristics, physical examination findings, and audiometric evaluation results.

Data Collection: A standardised questionnaire given by the investigator was used to gather data on the participants demographics, medical histories, physical examinations, and audiometric assessments.

Procedure: Audiological assessment was conducted using pure-tone audiometry in a quiet room, adhering to ISO standards. Air-conduction and bone-conduction tests were performed at specified frequencies. The pure tone average was calculated for each ear. Hearing thresholds were classified as normal (≤25dB), mild (26-40dB), moderate (41-55dB), moderately-severe (56-70dB), severe (71-91dB), or profound (>91dB).

Statistical Analysis: IBM SPSS Statistics was used for the data analysis process. The frequencies and distribution of the variables were ascertained using descriptive statistics. statistical analysis, with $p<0.05$ designated as the significance level.

Ethical Considerations: The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

Result

Table 1: Demographic profile

Variable	Haemodialysis Group (n=30)	Control Group (n=30)
Mean Age (years)	58.5 ± 7.6	52.3 ± 9.1
Gender		
Male	13	15
Female	17	15
Employment Status		
Employed	8	12
Unemployed	22	18
Education Level		
Primary	5	4
Secondary	12	14

Tertiary	13	12
Smoking Status		
Smokers	10	8
Non-smokers	20	22
Alcohol Consumption		
Yes	15	12
No	15	18

Sixty participants were involved in the study, comprising 30 CKD patients undergoing haemodialysis and 30 CKD patients not on dialysis, serving as controls. The average age of the participants was 55 years (SD = 8.2), with 45% being male and 55% female.

Table 2: Hearing Thresholds of Study Participants

Group	Haemodialysis (n=30)	Control (n=30)
Normal Hearing (≤25 dB)	12	24
Mild Hearing Loss (26-40 dB)	6	3
Moderate Hearing Loss (41-55 dB)	9	2
Moderately Severe Hearing Loss (56-70 dB)	2	1
Severe Hearing Loss (71-91 dB)	1	0
Profound Hearing Loss (>91 dB)	0	0

Audiometric evaluation revealed varying degrees of hearing loss among the participants. In the haemodialysis group, the mean pure-tone average was 48.5 dB (SD = 12.4), whereas in the control group, it was 31.2 dB (SD = 8.7). This variation was statistically relevant ($p < 0.001$), indicating a higher prevalence of hearing loss in the haemodialysis group. Among the haemodialysis group, 60% exhibited abnormal hearing thresholds (>25 dB), with 20% classified as having mild hearing loss, 30% moderate, and 10% moderately severe. In contrast, in the control group, only 20% showed abnormal hearing thresholds, with 15% mild hearing loss and 5% moderate. Comparison of hearing thresholds between the haemodialysis group and control group showed a statistically relevant difference ($p = 0.023$).

Table 3: Stage of CKD and Hearing Threshold among CKD Patients

Stage of CKD	Haemodialysis Group (n=30)	Control Group (n=30)
Stage 1	6.7%	16.7%
Stage 2	16.7%	20.0%
Stage 3	26.7%	23.3%
Stage 4	33.3%	30.0%
Stage 5	16.7%	10.0%

Further analysis revealed associations between hearing loss and both dialysis duration and kidney function. Within the haemodialysis group, there was a positive correlation between the duration of haemodialysis and severity of hearing loss ($r = 0.432$, $p = 0.011$), indicating that longer duration of haemodialysis was associated with worse hearing outcomes. Additionally, among the haemodialysis group, there was a negative correlation between kidney function (as measured by estimated glomerular filtration rate) and hearing thresholds ($r = -0.367$, $p = 0.032$), suggesting that poorer kidney function was related with higher hearing thresholds and worse hearing outcomes.

Discussion

The demographic profile of participants in the study revealed notable distinctions between the haemodialysis group and the control group. Individuals receiving haemodialysis were notably older, with a average age of 58.5 years in contrast to 52.3 years in the control group. While the haemodialysis group had a greater percentage of unemployed individuals (73.3%) in contrast to the control group (60%), this variation was not statistically relevant. Importantly, there were no substantial variations in gender distribution, education level, smoking status, or alcohol consumption between the two cohorts.

Audiometric assessments unveiled a significant disparity in hearing thresholds between the two groups. Participants undergoing haemodialysis exhibited substantially higher mean pure-tone averages, indicating poorer auditory function, compared to those in the control group. Moreover, a considerably higher proportion of individuals in the haemodialysis group displayed abnormal hearing thresholds (>25 dB) compared to the control group, highlighting a greater prevalence of hearing loss among haemodialysis patients. This statistically significant difference ($p = 0.023$)

underscores the association between CKD and hearing impairment.

Regarding the stage of CKD, there were notable differences in distribution between the haemodialysis and control groups. A larger percentage of individuals in the haemodialysis group were categorized as stage 4 CKD, whereas the control group had a higher percentage classified as stage 1 CKD. Although not statistically significant, these variations in CKD staging may contribute to the observed differences in hearing impairment between the two groups.

Further analysis delved into the relationships between hearing loss, dialysis duration, and kidney function within the haemodialysis group. A positive correlation emerged among the period of haemodialysis and the severity of hearing loss, suggesting that prolonged treatment may exacerbate auditory dysfunction. Additionally, a negative correlation was noted between kidney function (estimated glomerular filtration rate) and hearing thresholds, indicating that poorer kidney function was associated with higher hearing thresholds and worse hearing outcomes.

The study findings underscore a significant link between CKD, haemodialysis treatment, and hearing impairment. Individuals undergoing haemodialysis are particularly susceptible to hearing loss, with the severity potentially influenced by treatment duration and kidney function. Regular audiometric monitoring and timely intervention are crucial to mitigate the impact of hearing impairment on the quality of life of CKD individuals undergoing haemodialysis.

Recent research on CKD patients undergoing haemodialysis has highlighted significant impacts on auditory functions, specifically in hearing thresholds and the nature of hearing loss. A study clearly illustrates that haemodialysis patients exhibit increased hearing thresholds compared to non-dialysis individuals, indicating a direct effect of the treatment process on auditory health [5]. Building upon this, a study delve deeper into the type of hearing loss, identifying it as predominantly sensorineural and bilateral, with losses occurring across both high and low frequencies, and related to the duration of dialysis [6].

Further exploring the mechanisms behind this phenomenon, a study analyze how the severity of hearing loss at different frequencies can be influenced by the duration of the disease, pointing to the nuanced ways in which haemodialysis impacts hearing [7]. Recognizing the prevalence and patterns of hearing loss, a study advocate for routine audiological assessments to detect and manage hearing loss early, especially since the hearing impairment is often mild, bilateral, and sensorineural, affecting mainly the higher frequencies [8].

Additionally, a systematic review emphasizes the need for audiological evaluation before starting haemodialysis and regular follow-up, reinforcing the call for an integrated approach in the management of CKD that considers both renal and auditory health to optimize patient outcomes [9]. These studies collectively underscore the multifaceted challenges posed by haemodialysis in CKD patients, advocating for a comprehensive healthcare protocol that includes both renal management and audiological care.

Conclusion

The study offers valuable insights into the association between chronic kidney disease and hearing loss, emphasizing the importance of regular audiometric assessment in CKD patients, predominantly those undergoing haemodialysis, to mitigate the risk of auditory impairment.

Limitations: The cross-sectional form of the study limited its applicability by preventing the establishment of causal linkages. The results' generalizability was limited by the short sample size. Additional confounding variables, such as comorbidities and ototoxic medication use, were not fully accounted for in the analysis.

Recommendation: Regular audiological assessments should be integrated into the management plans for CKD patients undertaking haemodialysis to facilitate early detection and management of hearing loss, potentially enhancing their quality of life.

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List of abbreviations:

CKD: Chronic Kidney Disease

dB: Decibels

ISO: International Organization for Standardization

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