International Journal of Otorhinolaryngology and Head and Neck Surgery
Kanotra S et al. Int J Otorhinolaryngol Head Neck Surg. 2025 Feb;11(1):10-15
http://www.ijorl.com
pISSN 2454-5929 | eISSN 2454-5937
DOI: https://dx.doi.org/10.18203/issn.2454-5929.ijohns20250112

Original Research Article

Hearing loss in chronic kidney disease in north Indian population: a prospective study

Sonika Kanotra[1], Manjit Singh[1], Seerat Bashir[1], Rahul Gupta[2], Yasir Abbas Khan[1], Preeti Sharma[1]*, Neha Sharma[1], Shweta Purbi[1], Kshitij Gupta[3]

[1]Department of ENT Head & Neck Surgery, Government Medical College, Jammu, India
[2]Department of Urology, Super Speciality Hospital, Jammu, India
[3]ASCOMS, Jammu, India

Received: 10 November 2024
Revised: 16 November 2024
Accepted: 02 December 2024

***Correspondence:**
Dr. Preeti Sharma,
E-mail: 567sharmapreeti@ gmail.com

ABSTRACT

Background: Chronic kidney disease (CKD) is a global public health challenge. Patients with CKD show various otorhinolaryngological manifestations among which sensorineural hearing loss (SNHL) is the commonest**.** To determine the incidence of hearing loss and to describe the impact of chronic kidney disease on hearing in a tertiary care hospital of north India.
Methods: This was a prospective cross-sectional study on 60 cases of CKD and 60 controls attending the ENT OPD at SMGSH, Jammu after getting (Institutional Ethical Committee) IEC clearance.
Results: In the present study, 28 out of 60 patients of CKD had hearing loss. All the patients had SNHL in the high frequency range, sparing low and middle frequencies. There was a positive correlation between the stage and duration of CKD with hearing loss. Also, a significant correlation was found between the hearing loss and serum urea and creatinine levels.
Conclusion: It was concluded that patients with chronic kidney disease must be evaluated audiometrically at regular intervals, for early identification, management and rehabilitation of hearing loss in order to reduce the co-morbidity of hearing impairment and improve the quality of life of these individuals.

Keywords: Chronic kidney disease, Sensorineural hearing loss, Otoacoustic emissions, Pure tone audiometry, Distorted product otoacoustic emissions

INTRODUCTION

Chronic kidney disease is a global public health challenge. Inadequate excretion of metabolic waste products by the kidneys results in circulation of the nitrogenous toxic materials i.e., "uremic toxins" in the body which damage the tissues and organ systems.[1] Patients with CKD show otorhinolaryngological manifestations among which sensorineural hearing loss (SNHL) is the commonest. SNHL in CKD patients is usually bilateral with the prevalence of 63.5% in the Indian population.[2,3] Anatomical, physiological, pharmacological, pathological and antigenic similarities between the nephron and stria vascularis of the cochlea are responsible for the high incidence of SNHL in CKD.[4] The cochlea and the kidney are similar at the ultrastructural level.[5] The presence of basement membrane lined intercellular channels in both glomerulus and stria vascularis make them physiologically similar. Consequently, they share same basic processes for water and ion regulation which helps in maintaining fluid and electrolyte homeostasis in both the organs.[6] In addition, antibodies against the nephron are seen to deposit in the stria vascularis suggesting similar antigenicity.[7] The

possible etiopathogenic mechanisms of SNHL in CKD include osmotic changes leading to loss of hair cells, collapse of endolymphatic space, oedema and atrophy of specialised auditory cells.[8,9] Pharmacologically, several aetiological factors have been linked to hearing loss in renal failure including use of ototoxic medications, electrolyte disturbances, hypertension and hemodialysis treatment itself.[4,10-12]

The change in concentration of the ions is also thought to be responsible for hearing loss in CKD which suggests that there is a relationship of hyponatremia with the hearing loss in renal failure patients where correction of renal failure and restoration of serum sodium led to improvement of hearing loss.[13-16]

Since hearing involvement in patients of CKD is often neglected, this study was undertaken to assess the impact of CKD on hearing and to evaluate changes in OAE in such patients which might serve to predict impending hearing loss in CKD patients.

Thus, our study aims to determine the incidence of hearing loss and to describe the impact of chronic kidney disease on hearing in a tertiary care hospital of north India.

METHODS

This was a prospective cross-sectional study consisting of 120 participants (60 cases and 60 age and gender matched healthy controls) was conducted in the Department of Otorhinolaryngology and Head and neck surgery, SMGSH, Government Medical College Jammu from 1st November 2020 to 31st October 2021 after taking approval from the Institutional Ethical Committee (IEC), Govt. Medical College, Jammu.

A minimum sample size of 58 cases and 58 controls has been calculated on the basis of type-1 error =0.005, type-2 error =0.20 and prevalence of hearing loss i.e, P1 (cases) =34% and P2 (controls) =12% from the previous study conducted by Boateng JO et al by using Open Epi software version 3.1 However, we are considering 60 cases and 60 controls.

Inclusion criteria

Patients with CKD or CRF between 15-60 years age group who were willing to participate in the study were included in the study.

Exclusion criteria

Patients with history of hearing loss prior to CKD, any otologic infection/ surgery/trauma, any ototoxic medication prior to CKD, noise exposure prior to CKD, history of diabetes and history of renal transplantation were excluded from the study.

Work up of patients and controls

After obtaining informed consent, the patients and the controls underwent a detailed ENT examination with special emphasis on ear and tuning fork tests. They were subjected to audiological assessment i.e., PTA and OAE in a sound-treated room which conformed to American National Standards Institute (ANSI) (1977) and International Organization for Standardization (ISO) standards for maximum permissible noise level including PTA and OAE. Estimation of serum electrolytes and urea and serum creatinine was done.

Statistical analysis

The recorded data was compiled and entered in a spreadsheet (Microsoft excel) and then exported to data editor of statistical package for the social sciences (SPSS) version 2.0. Continuous variables were expressed as mean±SD and categorical variables were summarized as percentages.

RESULTS

The hearing loss was present in 28 (46.7%) out of 60 patients of CKD and 12 (20%) out of 60 subjects in controls. The difference of hearing loss between cases and controls was statistically significant with a p value of 0.002. All the patients were subjected to OAE which was refer in 36 patients whereas in the control group, OAE was refer in 12 patients. Out of the 36 patients with refer OAE, 20 patients had SNHL of mild to moderate degree on PTA.

In our study, out of 42 patients with CKD in the age group of 51-60 years, 26 (61.9%) had hearing loss and out of 8 patients with CKD in the age group 41-50 years, 2 (25%) had hearing loss. 10 patients were in the age group <40 years but none of them had hearing loss.

There was progressive increase in hearing loss with increase in age group. The difference was statistically significant with a p value of 0.0008. Out of 28 patients with SNHL, 18 (64.3%) had mild hearing loss, 10 (35.7%) had moderate hearing loss, none had moderately severe, severe or profound hearing loss. 12 normal subjects had mild SNHL.

The difference in the degree of hearing loss in cases and controls was statistically significant. 83.3% patients in stage 5 had hearing loss followed by 57% of patients with stage 4 disease.

2 out of the 12 patients of stage 3b had hearing loss. 85.7% (12 out of 14) patients with duration >24 months had hearing loss, 70% (14 out of 20) patients with 12-24 months duration of CKD had hearing loss and 7.7% (2 out of 26) patients with <12 months duration of CKD had hearing loss.

Table 1: Comparison of incidence of hearing loss in cases and controls.

Hearing loss	Cases		Controls		P value	OR (95% C I)
	No	%	No	%		
Present	28	46.7	12	20.0	0.002*	3.5 (1.56 – 1.87)
Absent	32	53.3	48	80.0		
Total	60	100	60	100		

*Statistically Significant Difference (p value<0.05)

Table 2: Correlation between age and hearing loss in study cases.

Age (in years)	N	Hearing loss		No hearing loss		P value
		No	%	No	%	
≤40	10	0	0.0	10	100	0.0008*
41-50	8	2	25.0	6	75.0	
51-60	42	26	61.9	16	38.1	
Total	60	28	46.7	32	53.3	

*Statistically Significant Difference (p value<0.05)

Table 3: Degree of hearing loss in cases and controls.

Degree of hearing loss	Cases		Controls		P value
	No	%	No	%	
Mild (26-40 dB)	18	64.3	12	100	0.0168
Moderate (41-55 dB)	10	35.7	0	0.0	
Moderately severe (56-70 dB)	0	0.0	0	0.0	
Severe (71-90 dB)	0	0.0	0	0.0	
Profound (>90 dB)	0	0.0	0	0.0	
Total	28	100	12	100	

Table 4: Association between stage and Hearing loss of CKD patients.

Stages of CKD	N	Hearing loss		No hearing loss		P value
		No	%	No	%	
Stage 1	0	-	-	-	-	<0.001*
Stage 2	6	0	0.0	6	100	
Stage 3a	2	0	0.0	2	100	
Stage 3b	12	2	16.7	10	83.3	
Stage 4	28	16	57.1	12	42.9	
Stage 5	12	10	83.3	2	16.7	
Total	60	28	46.7	32	53.3	

*Statistically Significant Difference (p value<0.05)

Table 5: Hearing loss as per duration of CKD.

Duration of CKD	N	Hearing loss		No hearing loss		P value
		No	%	No	%	
<12 Months	26	2	7.7	24	92.3	<0.001*
12-24 Months	20	14	70.0	6	30.0	
>24 Months	14	12	85.7	2	14.3	
Total	60	28	46.7	32	53.3	

*Statistically Significant Difference (p value<0.05)

DISCUSSION

Patients with CKD show otorhinolayngological manifestations among which sensorineural hearing loss (SNHL) is the commonest with a prevalence ranging from from 28% to 80% in the Indian population.[17-20] The incidence of hearing loss in our study was 46.7% in cases and 20% in controls (p-value of 0.002). The reason for this high incidence of SNHL are anatomical,

physiological, pharmacological, pathological and antigenic similarities between the nephron and stria vascularis of the cochlea.[4,21]

The cochlea and the kidney are similar at the ultrastructural level.[5] Physiologically, the inner ear and the kidney share some basic processes for water and ion regulation. Any derangement in the mechanisms which help in maintaining fluid and electrolyte homeostasis can explain the possible association of inner ear and kidney disease.[6]

Kidney and cochlea share similar antigenicity since antibodies against the nephron are also seen to deposit in the stria vascularis.[7,14] The possible etiopathogenic mechanisms of SNHL in CKD include osmotic changes leading to loss of hair cells, collapse of endolymphatic space, oedema and atrophy of specialized auditory cells and in some, may be a complication of haemodialysis.[8,11,14] Pharmacologically, several aetiological factors have been linked to hearing loss in renal failure including use of ototoxic medications, electrolyte disturbances, hypertension and hemodialysis treatment itself.[4,5,10-12] Inhibition of sodium reabsorption by loop diuretics leads to accumulation of sodium and water in the stria vascularis of the cochlea which brings the change in volume of endolymph and perilymph depending upon the serum sodium levels.[16] This volume change in the stria vascularis leads to separation of the intermediate cells from the marginal and basal cells.

The prevalence of sensorineural hearing loss increases with the increase in age and it has been observed that CKD accelerates presbycusis.[22] In our study, maximum patients were in the age group 51-60 years (70%). After matching age, gender and other factors of cases and controls, it has been observed that SNHL is more common in the patients of CKD.[7]

The distribution of males (60%) was more than females (40%) and thus, hearing loss was more in males as compared to females. Hence, we can say that gender had no significant relationship with hearing loss in CRF patients similar to the study conducted by Peyvandi A et al, and Jain et al.[13,18]

OAE is a sensitive and non-invasive method of objective cochlear investigation to detect inner ear dysfunction and it can be helpful in tracking dynamic changes in cochlear function. In the present study, among the cases, OAE was refer in 36 patients (60%) and pass in 24 patients (40%). In controls, OAE was refer in 12 subjects (20%) and pass in 48 subjects (80%). The difference was statistically significant with a p value of <0.001. Out of 36 patients with OAEs as refer, 28 had hearing loss which was detected on audiometry and in the rest 8 patients, hearing loss was not evident on audiometry. Since outer hair cell damage in the ear precedes neural damage, DPOAEs are said to have a predictive value in detecting hearing loss prior to development of measurable loss.[7] It can be said that patients who had OAEs as refer without any detectable hearing loss on audiometry may have an impending hearing loss which was picked up on OAEs.[8,9]

The high incidence of hearing loss in CKD can be attributed to uremic neuropathy, electrolytic, biochemical, osmotic, and vascular changes in the inner ear.[7,21] In the present study, 64.3% patients (18 out of 28) had mild hearing loss, 35.7% (10) had moderate hearing loss, none had moderately severe, severe or profound hearing loss in the cases. In control group, all the 12 subjects with hearing loss had mild degree of hearing loss. The difference in the degree of hearing loss in cases and controls was not statistically significant with a p value of 0.0168. Studies conducted by Balasubramanian et al, and Jain et al, showed that maximum number of patients had severe hearing loss (40% and 50% respectively) and less no. of patients had mild hearing loss (10% and none respectively).[17,18]

Patients of CKD have electrolyte imbalance, osmotic and immunological alterations at the inner ear level which leads to the development of hearing loss and these effects worsens with the progression of the disease as could be seen in our study.[17,21] There was a positive correlation of duration of CKD and hearing loss in our study as there were 14 patients with >24 months duration out of which 12 (85.7%) had hearing loss, 20 patients with 12-24 months duration out of which 14 (70%) had hearing loss and 26 patients with <12 months duration of CKD out of which 2 subjects (7.7%) had hearing loss, and.

Thus, it can be said that there was progressive increase in hearing loss with the increase in duration of CKD. The present study was consistent with the study conducted by Peyvandi et al, and Jain et al, who concluded that the hearing loss increased with the duration of CRF. The present study was also consistent with the study conducted by Meena et al, and Somashekara et al. However, they conducted the study on patients with haemodialysis.[2,13,18,23]

There was a progressive increase in hearing loss with the increase in stage of CKD which was statistically significant with a p value of 0.001. In our study, majority of patients were in stage 4 i.e. 28 out of which 16 (57.1%) had hearing loss followed by stage 5 having 12 patients out of which 10(83.3%) had hearing loss. There were 12 patients in stage 3b, out of which 2 patients (16.7%) had hearing loss. Stage 2 and 3a had 6 and 2 patients respectively but none of them had hearing loss. Thus, it can be said that the hearing loss increased with the increase in stage of CKD and there was a positive correlation of hearing loss with the stage of CKD in our study.

Studies conducted by Peyvandi et al, and Balasubramanian et al, demonstrated that the hearing loss was dominant in higher frequencies.[5,13,17,21] Similar pattern was shown in our study as all the 28 patients with

CKD had hearing loss in the high frequency range. Thus, it could be said that higher frequencies were more affected and there was relative sparing of the low and mid frequencies but the exact reason for the same has not been explained in the literature too. Gatland et al, found low and high frequency hearing loss in his study. However, he has attributed endolymphatic hydrops (Meniere's disease) like condition to be associated with low frequency hearing loss but no pathology has been explained regarding the high frequency hearing loss.[5,13,17] So, more research is needed in this regard.

Auditory brainstem studies of patients of CKD have demonstrated dysfunction of auditory nerve and pathways which may be because of uremic neuropathy and small vessel disease affecting cochlea and auditory pathway. These changes can be attributed to alteration in the electrolytes which ultimately results in osmotic changes leading to loss of hair cells, oedema and atrophy of specialized auditory cells.[17] Thus, there is a relationship of hyponatremia with the hearing loss in renal failure patients where correction of renal failure and restoration of serum sodium led to improvement of hearing loss.[13,14,16]

In our study, there was a statistically significant association of serum urea and creatinine levels with the hearing loss in patients of CKD with a p value <0.0001. The mean urea concentration of the patients of CKD with hearing loss was 81.81±53.18 mg/dl compared to controls where mean urea concentration of subjects with hearing loss was 16.12±4.35 mg/dl.

The mean creatinine concentration of the patients of CKD with hearing loss was 3.38±2.3 mg/dl compared to the controls where mean creatinine concentration of subjects with hearing loss was 0.08±0.12 mg/dl. The levels of serum creatinine and urea in patient with maximum hearing loss (48 dB) with stage 4 CKD with 36 months of duration of disease were 2.7 mg/dl and 80 mg/dl respectively whereas serum sodium and potassium were 131 mmol/l and 4.5 mmol/l respectively. Our study showed progressive increase in hearing loss with the increase in levels of serum urea and creatinine. Sreedharan et al, Jain et al, and Meena et al, found a positive correlation of hearing loss with serum urea levels but couldn't find a similar correlation with serum creatinine levels.[2,18,21]

No statistical significance was found between the mean levels of sodium and potassium with the hearing loss in patients of CKD similar to Blasubramanian et al.[17] However, Somashekara et al, found a positive correlation of hearing loss with low levels of sodium but not with potassium.[23]

Since our study was conducted over a limited period of time, we had small sample size. If comparison was performed with larger groups, the effect of chronic kidney disease on auditory function would have been better established. The study was conducted over a short duration with one time hearing assessment in each subject. Long term follow-up at frequent intervals is required in identifying the effect of chronic kidney disease on auditory function.

CONCLUSION

As per the findings of the present study, it was concluded that there was an association between sensorineural hearing loss and chronic kidney disease when compared to age matched healthy controls. There was a positive correlation between the stage and duration of CKD. Furthermore, the study also suggested that the CKD affects the severity of hearing loss and it affected the high frequency more as compared to low and mid frequencies. Also, a significant correlation was found between the hearing loss and serum urea and creatinine levels.

Thus, it can be concluded that patients with chronic kidney disease must be evaluated audiometrically at regular intervals, for early identification, management and rehabilitation of hearing loss in order to reduce the co-morbidity of hearing impairment and improve the quality of life of these individuals.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Boateng JO, Boafo N, Osafo C. Hearing impairment among chronic kidney disease patients on haemodialysis at a tertiary hospital in Ghana. Ghana Med J. 2019; 53(3):197-203.
2. Meena RS, Aseri Y, Singh BK. Hearing Loss in Patients of Chronic Renal Failure: A Study of 100 Cases. Indian J Otolaryngol Head Neck Surg. 2012;64(4):356-59.
3. Reddy EK, Surya Prakash DR, Rama Krishna MG. Proportion of hearing loss in chronic renal failure: Our experience. Indian J Otol. 2016;22(1):4-9.
4. Bergstrom L, Jenkins P, Sando I. Hearing loss in renal disease:clinical and pathological studies. Ann Oto Rhino Lary. 1973;82:555-74.
5. Gatland D, Tucker B, Chalstrey S. Hearing loss in chronic renal failure–hearing threshold changes following hemodialysis. J Roy Soc Med. 1991;84:587-9.
6. Akiyama K, Miyashita T, Matsubara A. The detailed localization pattern of Na+/K+/Cl-cotransporter type 2 and its related ion transport system in the rat endolymphatic sac. J Histochem Cytochem. 2010;58(8):759-63.
7. Vilayur E, Gopinath B, Harris DC. The association between reduced GFR and hearing loss: a cross-sectional population-based study. Am J Kidney Dis. 2010;56(4):661-69.

8. Davison AM, Cameron JS, Grunfeld JP. Oxford Textbook of Clinical Nephrology. 2nd edn. Oxford University Press, Oxford, UK. 1998: 625-46.
9. Stavroulaki P, Nikolopoulos TP, Psarommatis I. Hearing evaluation with distortion-product otoacoustic emissions in young patients undergoing haemodialysis. Clin Otolaryngol Allied Sci. 2001;26:235-42.
10. Bazzi C, Venturini C, Arrigo GD. Hearing loss in short and long term haemodialyzed patients. Nephrol Dial Transpl. 1995;10:1865-68.
11. Johnson DW, Wathen RL, Mathog RH. Effects of hemodialysis on hearing threshold. Ann Otol Rhinollarygol. 1976;85(1):43-9.
12. Serbetcioglu B, Erdogan S, Sifil A. Effects of a single session of hemodialysis on hearing abilities. Acta Otolaryngol. 2021;121:836-8.
13. Peyvandi A, Roozbahany NA. Hearing Loss in Chronic Renal Failure Patient Undergoing Hemodialysis. Indian J Otolaryngol Head Neck Surg. 2013;65(3):537-40.
14. Quick CA, Fish Brown C. The relationship between cochlea and kidney. Laryngoscope. 1973;83:1469-82.
15. Smilde TD, Damman K, van der Harst P. Different associations between renal function and ‘‘modifiable’’ risk factors in patients with chronic heart failure. Clin Res Cardiol. 2009;98(2):121-9.
16. Yassin A, Badry A, Fatthi A. The relationship between electrolyte balance and cochlear disturbances in cases of renal failure. J Laryngol Otol. 1970;84(4):833-43.
17. Balasubramanian C, Santhanakrishnakumar B, Anandan H. A study of hearing loss in chronic renal failure. Int J Sci Stud. 2018;5(10):15-8.
18. Jain A, Prasad B, Saboo R. To evaluate hearing pattern in cases of chronic renal failure. Indian J Basic Appl Med Res. 2016;6(1):706-13.
19. Meena RS, Aseri Y, Singh BK. Hearing Loss in Patients of Chronic Renal Failure: A Study of 100 Cases. Indian J Otolaryngol Head Neck Surg. 2012;64(4):356-9.
20. Sharma R, Gaur S, Gautam P. A study on hearing evaluation in patients of chronic renal failure. Indian J Otol. 2021;7(3):109-12.
21. Alder D, Fiehn W, Ritz E. Inhibition of Na+, K+ stimulated ATPase in the cochlea of guinea pig. A potential cause of disturbed inner ear functions in terminal renal failure. Acta Otolaryngol. 1980;90(2):55-60.
22. Sreedharan S, Prasad V, Bhatt J. Hearing loss in chronic renal failure - an assessment of multiple aetiological factors. Onl J Otolaryngol. 2015;5(2):71.
23. Somashekara KG, Chandre Gowda BV, Smitha SG. Etiological evaluation of hearing loss in chronic renal failure. Indian J Basic Appl Med Res. 2015;4(2):194-9.

Cite this article as: Kanotra S, Singh M, Bashir S, Gupta R, Khan YA, Sharma P, et al. Hearing loss in chronic kidney disease in north Indian population: a prospective study. Int J Otorhinolaryngol Head Neck Surg 2025;11:10-5.