

Original Research Article

DOI: <http://dx.doi.org/10.18203/issn.2454-5929.ijohns20202060>

Evaluation of hearing in patients of chronic renal failure

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Received: 03 February 2020

Revised: 06 May 2020

Accepted: 07 May 2020

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ABSTRACT

Background: Chronic kidney disease (CKD) is considered to be a major public health problem and only some studies have subsequently suggested the possibility of a link between the ear and the kidney. The aim of the study was to look for an association between the hearing loss and its association with CKD in absence of any underlying co-morbidities.

Methods: The study design was a hospital based cross sectional study. 50 patients diagnosed with CKD were included. The patients were subjected to general physical examination, examination of ear by otoscopy and hearing test by tuning fork test (256 Hz, 512 Hz and 1024 Hz). Pure tone audiometry (PTA) was also done.

Results: It was observed that 24% patients were having unilateral or bilateral hearing loss. Of the 12 patients with hearing loss, PTA threshold was below or equal to 35 dB in 4 patients. Hearing threshold of 45 dB was observed in 3 patients. All 3 patients had unilateral involvement. 2 had hearing loss in right ear whereas left ear was involved in 1 patient. 5 patients had hearing threshold between 45-60 dB. Of these 5 patients, 3 had bilateral ear involvement whereas unilateral ear involvement was seen in remaining 2 patients.

Conclusions: CKD is commonly associated with sensorineural hearing loss. The incidence was 24% in our study population. PTA can be a non-invasive procedure which may be employed to detect CKD patients suffering from any hearing loss.

Keywords: CKD, Sensorineural hearing loss, PTA, Hemodialysis

INTRODUCTION

Chronic kidney disease (CKD) is considered to be a massive health concern due to the increase in prevalence in adults, some studies have subsequently suggested the possibility of a link between the ear and the kidney.¹⁻³ The association between the two was first described by Alport 80 years ago as he found an association between familial kidney disease leading to hearing impairment.⁴ Vilayur et al reported that moderate CKD was associated independently with hearing impairment in a large community-based study after adjusting for age, sex, and other contributing factors.⁵ The kidney and stria vascularis of the cochlea have physiologic, ultra-

structural, and antigenic similarities which explained the link between CKD and hearing impairment.⁶ There are many factors that can contribute to cochlear dysfunction in patients with CKD, a combination and interaction of several factors could result in reduced cochlear functioning in patients with CKD. The cochlea and the kidney show many similarities such as membranous structures, the central role of ciliated epithelial cells, and tubular organization.⁶ Haemodialysis plays a major role to contribution of hearing loss in CKD.⁷ In this study, we studied the hearing profile in chronic kidney disease. We determined the incidence of hearing loss in patients of CKD and studied the type and degree of hearing loss in patients with CKD.

METHODS

This was an observational study which was carried out in patients attending the nephrology department of our hospital Dr D.Y. Patil Medical College and Hospital, Pimpri, Pune diagnosed with chronic renal failure during July 2017 to July 2019. The study was conducted after getting required clearance from Institutional ethical committee. 50 patients diagnosed with chronic kidney disease, attending nephrology clinic were examined based on the inclusion and exclusion criteria mentioned below.

Inclusion criteria

Patients diagnosed with chronic renal failure and age between 10 to 70 years were included.

Exclusion criteria

Patients younger than 10 years of age and older than 70 years of age, patients who have any otologic pathology prior to or after being diagnosed with chronic kidney disease and patients with other co morbid conditions in diabetes mellitus etc. were excluded.

The patients were examined general physical examinations to rule out other co morbid conditions; examination of ear, nose and throat to rule out any structural deformity or existing pathology; audiometric assessment using pure tone audiometry (PTA) was to identify hearing threshold levels in patients to determine the degree and type of hearing loss.

All eligible patients of either sex according to the inclusion and exclusion criteria were enrolled and informed consent for participation was taken. After taking the detailed history, patients were subjected to general physical examination, examination of ear by otoscopy to see the status of tympanic membrane and hearing test by tuning fork test (256 Hz, 512 Hz and 1024 Hz). PTA was done to access the type and severity of hearing loss at various frequencies.

Statistical analysis

The study design was a hospital based cross sectional study. Quantitative data is summarised in mean and standard deviation along with test of significance was done using standard statistical methods.

RESULTS

The majority of the patients in this study were male (58%) and females contributed to about 42%. The mean age in years was 40.74 ± 10.99 . The mean age of male participants was $41 \text{ years} \pm 10.29$. The mean age of the female subjects was $40.38 \text{ years} \pm 12.14$. The p value between age comparison of males and females was 0.85.

Hence there was no significant difference between age of patients in context of the gender.

The range of the age was 16 to 65 years. The age distribution was calculated. 7 patients were between 16 to 30 years of age, 17 patients were from 31 to 40 years of age, 18 patients were between 41 to 50 years of age, 6 patients were between 51 to 60 years of age and 2 patients were 60 year and above. It should be noted that peak of CKD was observed between 31-50 years of age, with 35 patients falling in this category.

The presenting complaints of the patients in context of renal disease were easy fatigability in 15, generalized weakness in 6, pedal edema in 11, periorbital edema in 8, puffiness of face in 2, leg swelling in 2 and itching over palm in 6 patients corresponding to 30%, 12%, 22%, 16%, 4%, 4% and 12% respectively.

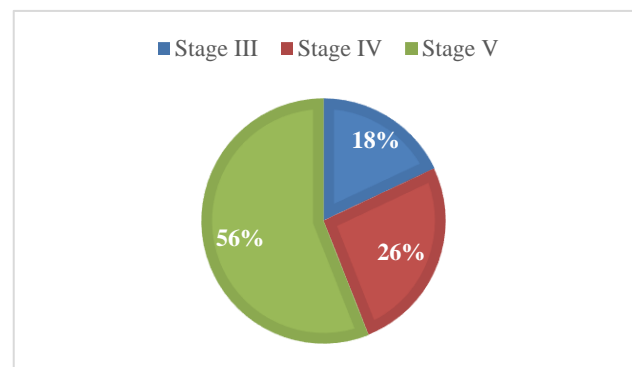


Figure 1: Severity of CKD in study participants.

Majority of the patients had stage 5 renal disease, followed by stage 4 and stage 3 chronic renal disease. Stage III CKD was present in 9, stage IV in 13 and Stage V in 28 patients corresponding to 18%, 26% and 56% respectively as shown in Figure 1.

Table 1: Incidence of hearing loss in study participants based on PTA.

| Side | Normal | 45-60 dB | 45 dB | 35 dB or less |
|-----------------------|--------|----------|-------|---------------|
| Bilateral | 38 | 3 | | |
| Right ear only | - | 1 | 1 | 3 |
| Left ear only | - | 1 | 2 | 1 |

PTA which is a reliable test for evaluating the hearing deficits was conducted in all the patients. The findings are depicted in Table 1. It was observed that 38 patients had acceptable hearing capacity with no hearing loss. Of the 12 patients with hearing loss, PTA threshold was below or equal to 35 dB in 4 patients. All 4 patients had unilateral hearing loss with right ear involvement in 3 whereas left ear involvement was seen in 1 patient. Hearing threshold of 45 dB was observed in 3 patients. All 3 patients had unilateral involvement. 2 had hearing loss in right ear whereas left ear was involved in 1

patient. 5 patients had hearing threshold between 45-60 dB. Of these 5 patients, 3 had bilateral ear involvement whereas unilateral ear involvement was seen in remaining 2 patients.

Table 2: Incidence of hearing loss in patients undergoing dialysis for CKD.

| Incidence of hearing loss | Frequency | Percentage |
|-------------------------------|-----------|------------|
| Patients with hearing loss | 12 | 24 |
| Patients without hearing loss | 38 | 76 |
| Total participants | 50 | 100 |

Table 3: Hearing loss based on involvement of ear.

| Hearing loss | Frequency | Percentage |
|--------------------------------------|-----------|------------|
| Unilateral hearing loss | 9 | 75 |
| Bilateral hearing loss | 3 | 25 |
| Total participants with hearing loss | 12 | 100 |

24% of the patients undergoing dialysis in this study group had hearing loss while the remaining majority of the patients (76%) didn't have any hearing loss.

Table 4: Involvement of ear in unilateral hearing loss.

| Unilateral hearing loss | Frequency | Percentage |
|-------------------------|-----------|------------|
| Right ear | 5 | 55.60 |
| Left ear | 4 | 44.40 |
| Total | 9 | 100 |

Table 5: Etiopathogenesis of CKD.

| Type of CKD | Frequency | Percentage |
|--|-----------|------------|
| Idiopathic | 29 | 58 |
| Polycystic kidney disease | 2 | 4 |
| IgA glomerulonephritis | 3 | 6 |
| Lupus nephritis | 1 | 2 |
| Interstitial nephritis | 1 | 2 |
| Renal tubulopathy | 2 | 4 |
| Chronic glomerulonephritis | 1 | 2 |
| Membranoproliferative glomerulonephritis | 2 | 4 |
| Minimal change disease | 4 | 8 |
| Pauci immune glomerulonephritis | 2 | 4 |
| Cresenteric glomerulonephritis | 1 | 2 |
| Drug induced nephropathy | 2 | 4 |

It was observed that 12 patients corresponding to 24% of the study population were having some amount of hearing loss which was either unilateral or bilateral.

Table 4 depicts ear involvement in unilateral hearing loss. Right ear was affected in 5 patients and left ear was involved in 4 in patients of unilateral hearing loss.

Idiopathic or unknown causes of CKD were the commonest encountered cases. Polycystic kidney disease, renal tubulopathy, membranoproliferative glomerulonephritis, pauci immune glomerulonephritis and drug induced nephropathy were encountered in 2 patients each (4% each); lupus nephritis, interstitial nephritis, cresenteric glomerulonephritis were encountered in 2 patients each (2% each); minimal change disease was encountered in 4 patients accounting for 8% whereas IgA nephropathy was detected in 3 patients corresponding to 6%.

Table 6: Urea and creatinine levels.

| Levels in mg/dl | Mean | SD |
|------------------|------|------|
| Urea level | 35.7 | 8.63 |
| Creatinine level | 8.17 | 2.90 |

Table 6 depicts blood urea and serum creatinine levels in the study participants. The mean blood urea levels in mg/dl were 35.7 ± 8.63 whereas the mean serum creatinine levels in mg/dl were 8.172 ± 2.9 . It should be noted that all the patients were on hemodialysis and the urea and creatinine values may not be reflective of the severity or stage of the disease.

Table 7: Usage of ototoxic drugs.

| Use of ototoxic drugs | Frequency | Percentage |
|-----------------------|-----------|------------|
| Yes | 6 | 12 |
| No | 44 | 88 |

Table 7 depicts concomitant use of any ototoxic drug. Six patients corresponding to 12% of the study population had exposure to ototoxic drugs.

Table 8: Ototoxic drugs used.

| Name of ototoxic drug | Frequency | Percentage |
|-----------------------|-----------|------------|
| Furosemide | 2 | 33.3 |
| Gentamicin | 2 | 33.3 |
| Amikacin | 2 | 33.3 |

Table 8 and depicts involvement of ototoxic drug. 2 patients were exposed to gentamicin, 2 patients were exposed to amikacin and 2 patients were on furosemide.

Aminoglycoside antibiotics (66.67%) were the most common class of ototoxic drugs used in this study followed by loop diuretics (33.33%) as depicted in Table 9.

The mean duration of hemodialysis in the study population. The mean duration in months for hemodialysis was 3.72 ± 1.72 months.

Table 9: Class of ototoxic drugs.

| Class of ototoxic drugs | Frequency | Percentage |
|----------------------------------|-----------|------------|
| Aminoglycoside antibiotic | 4 | 66.67 |
| Loop diuretic | 2 | 33.33 |

DISCUSSION

Our study evaluated hearing in patients suffering from chronic renal failure. A total 50 patients participated in the study. Out of 50 participants, 29 were males which corresponded to 58% and 21 were females which corresponded to 42% of the study population. In a similar study conducted by Gurbanov, there were 40 males and 23 females suffering from CKD evaluated for hearing loss corresponding to 63.49% and 36.51% respectively.⁸ In a study by Kang et al, 11 males and 11 females each were evaluated for sensorineuronal hearing loss while undergoing dialysis for CKD which corresponds to 50% each.⁹

Table 6 presents the levels of blood urea and serum creatinine levels in the study participants. The mean Blood urea levels in mg/dl were 35.7 ± 8.631338 whereas the mean serum creatinine levels in mg/dl were 8.172 ± 2.904679 . It should be noted that all the patients were on hemodialysis and the urea and creatinine values may not be reflective of the severity or stage of the disease. In a study by Seo et al.¹⁰ among various risk factors of CKD which can be associated with hearing loss, an analysis adjusted for age and gender of the patients determined that each increase of serum creatinine level or blood pressure level was significantly associated with an increase in hearing threshold (p value was significant and was <0.01). Hence it may be postulated that increased serum creatinine levels may be associated with hearing loss of higher threshold and hemodialysis by virtue of reduction in serum creatinine levels may have a beneficial effect on the same.

Idiopathic or unknown causes of CKD were the commonest encountered cases considering exclusion of cases with underlying co-morbid conditions such as diabetes mellitus and hypertension as these can be potential confounding factors in patients who develop hearing loss. The other reason of excluding patients with underlying co morbidities is due to the confounding effect of diseases such as diabetes mellitus and hypertension which also can result in significant hearing impairment over period of time and considering Diabetes mellitus and hypertension commonly account for most of the cases of chronic kidney disease.

Table 2 depicts the incidence of hearing loss in patients undergoing dialysis for CKD. It was observed that 12 patients corresponding to 24% of the study population were having some amount of hearing loss which was either unilateral or bilateral. This is depicted in Table 3, where unilateral hearing loss was observed in 9 patients

and 3 patients had bilateral hearing loss. Table 4 depicts ear involvement in unilateral hearing loss. Right ear was affected in 5 patients and left ear was involved in 4 in patients of unilateral hearing loss.

PTA which is a reliable test for evaluating the hearing deficits was conducted in all the patients. The findings are depicted in Table 1. It was observed that 38 patients had acceptable hearing capacity with no hearing loss. Of the 12 patients with hearing loss, PTA threshold was below or equal to 35 dB in 4 patients. All 4 patients had unilateral hearing loss with right ear involvement in 3 whereas left ear involvement was seen in 1 patient. Hearing threshold of 45 dB was observed in 3 patients. All 3 patients had unilateral involvement. 2 had hearing loss in right ear whereas left ear was involved in 1 patient. 5 patients had hearing threshold between 45-60 dB. Of these 5 patients, 3 had bilateral ear involvement whereas unilateral ear involvement was seen in remaining 2 patients. CKD has been predicted as independent risk factor for sensorineuronal hearing loss by various workers such as Govender et al who had evaluated function of cochlea.¹¹ They concluded that patients in later stages of CKD had early dysfunction of cochlea and they presented with subclinical hearing impairment. These were also confirmed by other workers such as Vilayur et al, Lin et al, Peyvandi et al amongst others.^{5,12,13}

Table 7 shows the concomitant use of any ototoxic drug. Six patients corresponding to 12% of the study population had exposure to ototoxic drugs. Table 8 depicts involvement of ototoxic drug. 2 patients were exposed to gentamicin, 2 patients were exposed to amikacin and 2 patients were on furosemide. Aminoglycoside antibiotics and loop diuretics are potentially ototoxic drugs. Ototoxic drugs used in CKD such as loop diuretics (furosemide) can impair ionic gradients between the endolymph and perilymph. This can result in edema of striavascularis especially in the epithelial area leading to hearing impairment.¹⁴

Among aminoglycosides group of antibiotics gentamycin and streptomycin are toxic to vestibule in particular, whereas other antibiotics in this group such as amikacin, neomycin, kanamycin, plazomicin are harmful to the cochlea primarily. The symptoms of cochlear damage include permanent hearing impairment and damage to the vestibule apparatus which can cause vertigo, ataxia, and may be associated with nystagmus. Aminoglycosides group of antibiotics appear to generate free radicals species in the inner ear. These damage sensory cells and neurons, resulting in permanent hearing impairment. Two mutations have been detected in the mitochondrial 12S ribosomal RNA gene that can predispose individuals carrying these genes to aminoglycoside antibiotic induced toxicity to inner ear.¹⁵

The mean duration of hemodialysis in the study population. The mean duration in months for

hemodialysis was 3.72 ± 1.72 months. There has been controversial view regarding hemodialysis and its effect on hearing. Lopez et al evaluated patients based on dialysis status and effect on hearing.¹⁶ They concluded that conservative treatment group who did not underwent dialysis presented worse audiological tests, irrespective of presence of hypertension and diabetes. Hence, hemodialysis might have beneficial effect considering this study. Haemodialysis has also been known to contribute to hearing loss in patients with CKD as reported by Samir et al.⁷

CONCLUSION

CKD is commonly associated with sensorineural hearing loss. The incidence was 24% in our study population. PTA can be a non invasive procedure which may be employed to detect CKD patients suffering from any hearing loss. The peak duration of CKD was seen from between 31-50 years of age. Idiopathic causes constituted majority for etiopathogenesis of CKD at 58%. Incidence of use of Ototoxic drugs was 12%. This can be easily avoided with alternate drugs and may be one of the significant reasons for prevention of hearing loss in CKD patients. PTA threshold was below or equal to 35 dB in 4 patients. All 4 patients had unilateral hearing loss with right ear involvement in 3 whereas left ear involvement was seen in 1 patient. Hearing threshold of 45 dB was observed in 3 patients. All 3 patients had unilateral involvement. 2 had hearing loss in right ear whereas left ear was involved in 1 patient. 5 patients had hearing threshold between 45-60 dB. Of these 5 patients, 3 had bilateral ear involvement whereas unilateral ear involvement was seen in remaining 2 patients.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Mukhtar S, Thomas J, Ghatge G, Khan R. Evaluation of hearing in patients of chronic renal failure. *Int J Otorhinolaryngol Head Neck Surg* 2020;6:1069-73.