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Original Research Article

Evaluation of hearing acuity in patients with chronic renal failure by pure tone audiometry

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ABSTRACT

Background: Hearing loss is common in patients with chronic renal failure. It is well known that chronic renal failure (CRF) causes different systemic and otorhinolaryngologic manifestations due to the accumulation of nitrogenous waste products. The aim of the study was to evaluate hearing threshold and the severity of hearing loss at different frequencies in patients of chronic renal failure (CRF), and to analyse the role of duration of disease on hearing threshold in patients of CRF.
Methods: Fifty two patients of CRF were included in the study. Pure tone audiometry was done in all cases.
Results: Majority of the patients were in 21 to 40 year age group (mean: out of 52 patients, 38 patients (73.07%) had sensorineural hearing loss and 14 patients (26.93%) had normal hearing. Majority of the patients with hearing loss had mild (44.73%) or moderate (42.11%) sensorineural hearing loss. On comparison of the mean hearing threshold Group II (duration of disease more than five years- 17 patients) showed a statistically significant difference ($P<0.05$) in mean hearing threshold at 250 Hz.
Conclusions: Hearing loss is present in majority of the patients of CRF. Most of the cases have mild to moderate sensorineural hearing loss. High frequency hearing loss in chronic renal failure is related to the duration of the disease, duration of haemodialysis' and internal homeostasis, namely hyponatremia.

Keywords: Chronic kidney disease, CRF, Sensory neural hearing loss (SNHL) audiometry

INTRODUCTION

Sensorineural hearing impairment has been reported in chronic renal failure (CRF) patients with a prevalence of 20-40%. The aetiopathogenetic mechanisms reported included osmotic alteration resulting in loss of hair cells, collapse of the endolymphatic space, edema, and atrophy of specialized auditory cells and in some complications of haemodialysis.[1] Hearing impairment has been reported in patients with CRF. There are also certain anatomic similarities at an ultrastructural level and evidence for similar antigenicity of the cochlea and kidney.[2-4]

Multiple shared risk factors for chronic kidney disease (CKD) and hearing loss include age, diabetes, hypertension, and medications that are both ototoxic and nephrotoxic

Moreover, in patients with established CKD, multiple risk factors have been hypothesized to cause hearing loss including the use of ototoxic medications, hypertension, and diabetes, particularly in association with hypertension, electrolyte disturbances, and haemodialysis' itself.[5-7] Older adults with moderate CKD have a higher prevalence of hearing loss than those of the same age without CKD according to recent studies. Although several causes and prevalence of renal disease related hearing loss have been proposed the etiology and proportion are still controversial. The exact pathophysiological mechanism underlying the presence

of hearing loss among CKD patients is unknown although several potential mechanisms have been hypothesized. The kidney and the stria vascularis of the cochlea share physiological, ultrastructural, and antigenic similarities that could explain the association between CKD and hearing loss.

This study was aimed to evaluate the severity of hearing loss at different frequencies in patients of chronic renal failure) and to analyze the role of duration of disease on hearing threshold in patients of CRF.

METHODS

A prospective study was conducted over period of one year from December 2018 to December 2019 at our institution, with the approval of the institute ethics committee and in accordance with ethical standards.

The patients included in the study were cases of CRF attending nephrology unit at a tertiary care centre. The criterion for diagnosis of CRF was decrease in kidney glomerular filtration rate (GFR) of less than 60 ml/min/1.73 m^2 for three or more months.

The aim of the study was to evaluate the hearing at different frequencies in patients of chronic renal failure and to study the correlation between hearing loss and duration of chronic renal failure.

A total of 52 patients were included in the study group (28 male and 24 female). These cases were evaluated in nephrology unit and ENT OPD. Cases with past history of hearing loss, ear discharge, diabetes, and hypertension were not included in the study. Thereafter, all patients were subjected to basic tests of renal function Hb, blood urea, serum creatinine, and blood urea nitrogen. On the basis of the findings of biochemical investigations, GFR was calculated. All these patients were then subjected to clinical evaluation and pure tone audiometry at 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz, and 8000 Hz in a sound treated room.

The findings on audiometry were noted and patients were classified according to WHO classification for pure tone audiogram. In 38 patients with hearing loss, mean hearing threshold was calculated at 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz, and 8000 Hz to evaluate the severity and pattern of hearing loss in chronic renal failure.

To study the effect of duration of disease on hearing threshold all patients of chronic renal failure were divided into two groups- with duration of disease less than five years (21 cases) and more than five years (17 cases). The mean hearing thresholds at different frequencies were compared in both the groups. The significant differences between the hearing thresholds of these two groups were assessed using student's t test for unequal samples.

RESULTS

Out of 52 patients, 28 (53.84%) were males and 24 (46.16%) were females. A total of 71.15% (37/52) of the patients were in 21 to 40 year age group (Table 1). Of 52 patients, 38 patients (73.07%) had sensorineural hearing loss and 14 patients (26.93%) had normal hearing on pure tone audiogram (Table 2). Majority of the ears had mild (44.73%) or moderate hearing loss (42.11%).

Table 1: Age and sex distribution of patients of chronic renal failure in the study group (number of patients 52).

Age group	Number of male patients	Number of female patients	Total no. (percent) of patients
1-20 years	5	2	7 (13.46)
21-40 years	20	17	37 (71.15)
41-60 years	3	3	6 (11.54)
61-80 years	-	2	2 (3.84)
Total no. of patients	28 (53.84)	24 (46.16)	52

Table 2: Severity of hearing loss in patients of chronic renal failure.

Hearing loss	Number of patients with hearing loss (n=38)	Percentage of patients
Mild hearing loss (26 to 40 dB)	17	44.73
Moderate hearing loss (41 to 55 dB)	16	42.11
Moderately severe hearing loss (56 to 70 dB)	4	10.52
Severe hearing loss (71 to 91 dB)	1	2.63
Profound hearing loss (More than 91 dB)	--	-
Total patients	38	

Table 3: Comparison in between duration of CRF in patients with hearing loss.

Duration in years	Number of patients with hearing loss (n=38)	Percentage of patients
<5 years	17	44.73%
>5 years	21	55.26%
Total number of patients	38	

The mean hearing threshold in 38 patients with sensorineural hearing loss was higher at 250 Hz, 500 Hz, 6000Hz, and 8000 Hz as compared to mean hearing threshold at 1000, 2000, 3000, and 4000 Hz. Out of 38

patients with hearing loss, number of patients with duration of CRF less than five years were 17 (44.73%), while number of patients with duration of chronic renal failure more than five years were 21 (55.26%) (Table 3). There was a significant difference ($p<0.05$) in mean hearing threshold in two groups. Out of 38 patients with hearing loss 15 patients (39.47%) had serum creatinine levels between 10-15 mg% (Table 4).

Table 4: Serum creatinine levels in patients with hearing loss.

Serum creatinine level in mg%	Number of patients With hearing loss (n=38)	Percentage of patients
15-20	4	10.52%
10-15	15	39.47%
5-10	9	23.68%
1.5-5	10	26.31%
Total	38	

DISCUSSION

Although the gross anatomy of the kidney and cochlea differ, a very many similarities exist between the nephron and the stria vascularis at the anatomical, physiological, pharmacological, pathological and ultra-structural levels. All this may make the nephron and the stria vascularis susceptible to the same type of haemodynamic or pharmacological insults.[1]

Chronic renal failure is characterized by gradually progressive loss of renal function. It is a major cause of morbidity and mortality, particularly in later stages of disease. Approximately one million nephrons are present in each kidney, each contributing to the total GFR. Regardless of the etiology of renal injury, there is gradually progressive destruction of nephrons in patients of chronic renal failure. The kidney has an innate ability to maintain GFR by hyperfiltration and compensatory hypertrophy of the remaining healthy nephrons. The adaptive changes in nephron lead to maladaptive consequences i.e. increase in glomerular filtration causing glomerular injury. Abnormal glomerular permeability further leads to proteinuria. When the renal reserve exhausts, it leads to an increase in plasma level of urea and creatinine.[1] Possible cause of uremic manifestations in chronic renal failure is due to accumulation of toxins due to impairment of renal function. As a result the blood becomes too acidic, bones starts loosing calcium, and nerves starts degenerating leading to sensorineural hearing loss.

Deafness in chronic renal failure

Sensorineural hearing loss in patients of chronic renal failure is relatively higher in comparison to the general population. Quite a good number of studies show that patients of chronic renal failure have sensorineural hearing loss.[2-4] In the present study, 73.07% of the ears had sensorineural hearing loss and 26.93% of the ears had normal hearing. Almost similar results were reported by Bazzi et al (sensorineural hearing loss in 77%), Kusakari et al (60% of the patients had hearing loss) and Charachon (sensorineural hearing loss in 75% cases) in patients of chronic renal failure.[5-7] Kusakari also reported that 36% of the patients had vestibular dysfunction and 26% had a combination of hearing and vestibular dysfunction. Vestibular dysfunction was not evaluated in the present study.

Majority of the patients in the present study had mild to moderate sensorineural hearing loss. A total of 44.73% of the ears had mild sensorineural hearing loss, while 42.11% of the ears had moderate sensorineural hearing loss. Ozturan reported moderate to severe hearing loss in 46% of patients of chronic renal failure.[8] Only a few studies are available showing the mean hearing threshold at all frequency levels. The mean hearing threshold varied from 29.40 dBHL at 1000 Hz to 38.35 dBHL at 8000 Hz. The mean hearing threshold at low frequencies (250 Hz and 500 Hz) and at higher frequencies (4000 Hz, 6000 Hz, and 8000 Hz) was relatively more as compared to that mid frequencies (1000 Hz and 2000 Hz) suggesting the predilection for high and low frequencies involvement in patients of chronic renal failure. Gatland et al reported incidence of deafness as 41% in low frequencies, 15% in mid frequencies, and 53% in higher frequencies.[9] However, Johnson et al and Antonelli et al, reported only high frequency hearing loss in patients of chronic renal failure.[10] Ozturan reported a notch at 6 Khz in patients of chronic renal failure. Stavroulaki et al found hearing loss in 55.5% of the children with CRF, with hearing mainly affected at higher frequencies (12 Hz).[11]

A variety of causes like electrolyte imbalance, high blood pressure, use of ototoxic medication, vitamin D deficiency, and inhibition of Na+ K+ activated ATPase enzyme (important for maintaining cationic gradients in cochlea) have been suggested for sensorineural hearing loss in patients of chronic renal failure.[12,13]

Correlation in hearing loss with duration of treatment

There was a statistically significant difference in hearing threshold at 250 Hz suggesting deterioration of hearing at low frequency as the duration of disease increases. This is a significant finding and needs to be studied further in studies with large number of patients. Henrich et al showed found that 75% of patients showed no deterioration of hearing during a four-year time of follow-up.[14]

CONCLUSION

High frequency hearing loss seen in CRF is related to the duration of the disease, duration of haemodialysis and internal homeostasis through levels of serum electrolytes and nitrogenous end products of metabolism. Evidence of

a possible link between kidney function and hearing loss, as suggested by our study, potentially could modify the usual care of people with CKD. It should encourage clinical nephrologists to include questions about hearing function in their preventive care protocols, to refer all patients reporting hearing loss for audiological evaluation and/or rehabilitation (e.g., hearing aids), and recommend that patients avoid further treatment with ototoxic medications to preserve their hearing ability.

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