

Correlation Between Aetiology, Stage and Duration of Chronic Kidney Disease and Hearing Loss

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ABSTRACT

Background: The incidence of chronic kidney disease (CKD) in Nigeria and the Black race in general is on the increase with attendant high morbidity and mortality. Several aetiological factors have been implicated in CKD which include hypertension, diabetes mellitus, glomerulonephritis, obstructive uropathy, recurrent pyelonephritis and adult polycystic kidney disease (ADPKD) amongst others. Whatever maybe the aetiological factor of the CKD, there is reported effect of this condition on the auditory organ at the level of cochlea because of certain similarities. **Objective:** To determine if there is any correlation between the aetiology, stage and duration of chronic kidney disease with the severity of hearing loss. **Methodology:** A one-year prospective study which sought information on demographics, aetiological factors, otologic, drug and occupational histories of patients with chronic kidney disease using a structured interviewer administered questionnaire. Additionally, body weight, height, blood pressure, fasting blood sugar and serum creatinine were measured for all the patients while pure tone audiometry (PTA) and glomerular filtration rate (GFR) were measured or calculated respectively.

Results: One hundred CKD patients were analysed, comprising of 66 males and 34 females with a male to female ratio of 1.9:4. Their ages ranged from 15 years to 75 years with mean age of 40.2 (SD±18.4). The majority of the studied population was in the 45-54 years (28%). Sensorineural high frequency hearing loss was found in 60 patients, made up of 49 in both ears and 11 unilateral (3 and 8 in right and left ears respectively). These gave a total of 109 ears (54.5%). Chronic kidney disease resulting from chronic glomerulonephritis or hypertension accounted for 45.0% and 36.0% cases respectively. Hearing loss increases with the CKD stage accounting for 15.6%, 34.9% and 48.6% for stages 3, 4 and 5 respectively. The longer the duration of the CKD, the more depressed was the mean hearing threshold ($P=0.0047$; $r=0.870$).

Conclusion: There is significant correlation between hearing loss in the high frequencies and duration and stage of chronic kidney disease patients. Therefore, we recommend health education with a view to identifying this category of patients' early and effecting periodic hearing assessment in them.

Keywords: Aetiology, Stage, Duration, Chronic Kidney Disease, Hearing loss.

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Introduction

The incidence of chronic kidney disease (CKD) in Nigeria and the Black race in general is on the increase with attendant high morbidity and mortality.¹⁻³ CKD is defined as glomerular filtration [GFR] of less than 60ml/min/1.73m² or kidney damage for ≥ 3 months. At this GFR, the kidneys have lost half or more of their normal function. Kidney is said to be damaged when there are pathologic abnormalities or presence of

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markers of damage in the blood, urine or imaging studies⁴. In their study of chronic kidney disease in Jos, Agaba et al⁵ found a prevalence of 8.8% of all medical admissions. They warned of a possible increase as a result of the rising aetiological factors and recommended integration of primary renal care into the National Health Care Policy. Although, the kidneys are primarily affected in CKD, the resultant loss of half or more of their normal functions affect various organ systems with complications that are either direct effect of the CKD or the adaptive mechanisms of the body in response to the disturbed homeostasis.⁶ Several aetiologic factors have been implicated in CKD which include hypertension, diabetes mellitus, glomerulonephritis, obstructive uropathy, recurrent pyelonephritis and adult polycystic kidney disease (ADPKD) amongst others.^{2,5} CKD is classified into 5 stages namely: stage 1 kidney damage with normal or increased GFR (≥ 90 ml/min/1.73m²); stage 2 kidney damage with mild reduction in GFR (60-89 ml/min/1.73m²); stage 3 kidney damage with moderate reduction in GFR (30-59 ml/min/1.73m²); stage 4 kidney damage with severe reduction in GFR (15-29 ml/min/1.73m²) and stage 5 is kidney failure with GFR (<15ml/min/1.73m²). Stage 5 CKD patients require initiation of kidney replacement therapy (dialysis or renal transplantation).

Whatever maybe the aetiological factor of the CKD, the effects of this condition on the auditory organ is mainly on the cochlea where several mechanisms such as changes in the homeostasis of fluid and electrolyte distort the normal milieu of endolymph that bathes the sensory hair cells or drug ototoxicity due to similarities between cochlea and kidney or atherosclerotic changes of vascular walls which may result in decreased blood flow to the inner ear structures.

This is because of the reported similarities between the kidneys and the cochlear in their anatomical, pharmacological, pathological and antigenic property as well as physiological mechanism like active transport of fluid and electrolytes accomplished by the renal tubules and stria vascularis respectively.^{7,8} Normal hearing as defined by WHO is average hearing threshold of ≤ 25 dBHL at the speech frequencies of 500Hz, 1000Hz, 2000Hz and 4000Hz. Furthermore, hearing impairment is graded into mild loss (26-40 dBHL), moderate loss (41-

55dBHL), moderately- severe loss (56-70dBHL), severe loss (71-90dBHL) and profound loss (≥ 91 dBHL).⁹ Hearing loss could also be classified as conductive, sensorineural or mixed. The author's earlier research work and few others had reported hearing loss and effect of haemodialysis on hearing threshold among CKD patients which was attributed to several factors.¹⁰⁻¹² This study aims to correlate the aetiology, the stage and the duration with the hearing loss.

Methodology

This was a hospital-based one year prospective, descriptive study to assess the correlation between the aetiology, the stage and the duration with the severity of hearing loss in both adolescents and adults CKD patients conducted in Jos University Teaching Hospital from January to December 2012. This study was approved by the institutional ethics and research committee (JUTH/DCS/ADM/127/XXVI/1568). Sample size was determined using the Fisher's formula: $n = Z^2Pq/d^2$.¹³ The sample size was 96 but a total of 103 patients were recruited to allow for 10% attrition from incomplete data collection. Three patients were excluded for this reason. The patients were recruited consecutively from the renal clinic and assessed in a sound-proof booth located in the adjoining Ear, Nose and Throat clinic area. Non-probability sampling technique was done and no inpatients were recruited. Only newly-diagnosed patients who consented and met the inclusion criteria were recruited.

The instrument for the study was a structured interviewer administered questionnaire to obtain data from patients who gave informed written consents. The questionnaire had sections on biodata and duration of illness; known medical conditions (hypertension, diabetes mellitus, obstructive uropathy, glomerulonephritis, recurrent pyelonephritis and adult polycystic kidney disease (ADPKD), autoimmune disease, systemic infection/urinary tract infection); drug history (drug reactions, ototoxic drug administration, and native drug use); otological history (hearing loss, ear discharge, otalgia, tinnitus, dizziness/vertigo, familial deafness, ear surgery or head injury); and occupational history/noise exposure.

The body weight, height, blood pressure, fasting blood sugar and serum creatinine were measured for all the patients and glomerular filtration rate



(GFR) calculated using the appropriate formula¹⁴ with a view to determining the stage of the CKD. Otoscopy and removal of wax (if any) was done. Pure tone audiometry (PTA) using a standard, duly calibrated Interacoustics Audiometer (226A) was done by a clinical audiologist in a sound-proof room to determine their hearing thresholds. Air conduction threshold was determined for octave frequencies of 500Hz, 1000Hz, 2000Hz, 4000Hz, 6000Hz and 8000Hz while bone conduction (BC) at 500Hz, 1000Hz, 2000Hz and 4000Hz. The individual patient was seated and fitted with appropriate sized head phones and instructed to raise a hand or press the response button on hearing the emitted sound no matter how faint. The test was started at 1000Hz with the presentation of sound at 50dB.

An ascending-5dB and descending-10db steps method was utilized to determine pure tone thresholds three times at the above frequencies. Each ear was tested separately with the other adequately masked.

The pure tone average was determined for an individual from the audiogram by calculating the mean decibel loss at frequencies of 500Hz, 1000Hz, 2000Hz and 4000Hz for speech frequencies and 6000Hz and 8000Hz for the high frequencies. Participants were considered impaired when their hearing threshold level exceeded 26dBHL and classified accordingly.

Data Analysis

The data were presented in tabular forms and analyzed with statistical package for social science (SPSS) version 20.0.

Relationships between variables were assessed using Chi-Square. A P-value <0.05 was considered statistically significant.

Results

A total of one hundred and three patients were recruited but 3 had incomplete data and were excluded. Therefore, a total of 100 patients completed the study and were analyzed. They were 66 males and 34 females with a male to female ratio of 1.9:4. Their ages ranged from 15years to 75years with mean age of 40.2(SD±18.4). The majority of the studied population was in the 45-54 years (28%). See Table 1.

Sensorineural high frequency hearing loss was found in 60 patients, made up of 49 in both ears

and 11 unilateral (3 and 8 in right and left ears respectively). These gave a total of 109 ears (54.5%). Although, not statistically significant, chronic kidney disease resulting from chronic glomerulonephritis or hypertension caused more high frequency hearing loss than any other pathology accounting for 45.0% and 36.0% respectively.

There was correlation between the duration of the CKD and the mean hearing threshold of the patients (P=0.0047; r=0.870). (See Table)

The number of patients with hearing loss increases with the CKD stage. However, this association was not statistically significant (see Table 4).

The degree of hearing loss in the high frequencies among the patients showed mild hearing loss occurring most frequently in 69 ears (63.3%), moderate in 27 ears (24.8%), and moderately-severe in 13 ears (11.9%).

Vertigo and tinnitus were the commonest otorhinolaryngologic symptoms in 74 patients with the former occurring in 56 of them. Eighteen patients were discovered to have impacted cerumen auris on otoscopy which were either manually removed or syringed out after softening with cerumenolytics.

Discussion

Hearing loss in CKD both in the speech and high frequencies has been established by some researchers. It is put at between 20%-80% especially in stage 5 CKD patients.^{10-12,15} Correlations were found between the severity of the hearing loss in CKD patients and certain variables such as age, duration of CKD and treatment modality. High frequency hearing loss in this study was found to be 54.5%. This was similar to the findings of Adekwu et al (37.7%),¹⁰ Bergstrom and Thompson (47%),¹⁶ Nikolopoulos et al (30.4%)¹⁷ and Zeigelboim et al¹⁸ (80%). There were no contrasting studies, however, whereas the former's sample population cuts across all ages, the later concentrated more on younger patients. Zeigelboim's studied population was in their middle ages and additionally they used ultra-high frequency (9-18Kz) hearing assessment which could have accounted for the high yield. The hearing loss found in all the studies was



typically sensorineural and most of the patients had mild degree of hearing loss.

There was positive correlation between hearing loss and duration of the CKD in this study. This agreed with studies by Lasisi et al¹² and Gatland et al¹⁹ and could be as a result of insidious destruction of the cochlear that is attributable to the uremic process. However due to the insidious course of the hearing loss, or compensatory mechanisms (adaptation) the disability arising from it may not be noticeable in the early phase of the disease until the late phase.

The higher the stage of the CKD, the worse was the hearing threshold, though this was not statistically significant. Therefore, stage 5 had the highest number of patients with hearing loss accounting for 48.6%. This too was similar to the findings of Lasisi et al¹² and Bergstrom et al¹⁶. Males were more affected than females while the majority of the studied population was in the 4th and 5th decades of life. Many of the cited studies had similar findings. The vertigo and tinnitus that were the commonest otorhinolaryngologic

symptoms could be attributable to derangements in inner ear function occasioned by pathological effects of CKD.^{2,8,20}

Limitation of our study is the non-availability of test tools such as Otoacoustic emission and Brainstem evoked response audiometry as well as inability to assess high frequency beyond 8kHz. However, pure tone audiometry is an acceptable objective hearing assessment tool especially in third world countries such as ours where many health facilities are poorly funded.

Conclusion

This study established a significant correlation between hearing loss especially in the high frequencies and duration and stage of chronic kidney disease patients. Therefore, we recommend health education with a view to identifying this category of patients' early and effecting periodic hearing assessment in them.

Table 1: Age group distribution of patients

Age group (Years)	Number of Patients n=100 (%)
15- 24	22 (22)
25- 34	10 (10)
35- 44	14 (14)
45- 54	28 (28)
55- 64	20 (20)
65 and above	6 (6)
Total	100 (100)

Table 2: Cause of CKD and mean high frequency hearing thresholds

Cause of CKD	Frequency of hearing loss N (%)	Frequency of no hearing loss N (%)	Mean AC high frequency threshold (dBHL)
Adult polycystic kidney disease (ADPKD)	1 (1.7)	0 (0.0)	29.3
Recurrent Pyelonephritis	1(1.7)	1(2.5)	28.7
Obstructive Uropathy	3(5.0)	5(12.5)	26.6
Diabetes Mellitus	6(10.0)	7(17.5)	27.8
Hypertension	22(36.0)	16(40.0)	34.6
Chronic glomerulonephritis	27(45.0)	11(27.5)	40.1
Total	60(100.0)	40(100.0)	

Statistics $\chi^2=5.48$; df= 5; p-value = 0.3601



Table 3: Duration of CKD and mean hearing thresholds

Duration of CKD(years)	Number of patients n=109 ears (%)	Unilateral Mean AC hearing thresholds dBHL (BC)
1-3	71 (65.1)	27.6 (24.2)
4-6	20 (18.4)	34.6 (31.9)
7-9	12 (11.0)	36.1 (34.2)
≥10	6 (5.5)	37.4 (35.9)
Total	109 (100)	
Statistics	P=0.0047	(r=0.870)

Table 4: Stage of CKD and mean hearing thresholds

Stage of CKD	Number of patients n=109 ears (%)	Unilateral Mean AC hearing thresholds dBHL (BC)
1	0 (0)	0 (0)
2	1 (0.9)	28.2 (25.4)
3	17 (15.6)	39.1 (36.3)
4	38 (34.9)	47.6 (43.8)
5	53 (48.6)	59.3 (50.1)
Total	109 (100)	
Statistics	P=0.210	(r=1.24)

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