STUDY OF HEARING LOSS IN PATIENTS WITH CHRONIC KIDNEY DISEASE

Objectives:
To study the hearing loss in patients with chronic kidney disease.

Materials and methods:
This case control study of 50 CKD patients and 50 age (±5) matched population was conducted in the Department of Otolaryngology Head and Neck Surgery and Department of Internal medicine, B.P. Koirala institute of Health Sciences, Dharan, between July 2007 to December 2008. Otological examination was carried out in all the subjects. Middle ear pathology and conductive hearing loss excluded. Pure tone audiometry was carried out on each case and control (patient/participant) in a sound-proof room. Data was collected and analyzed. The sensory neural hearing loss of the CKD patients was compared with the healthy controls.

Results:
We found sensory neural hearing loss in 46% of CKD patients and 43% in normal population. High frequency hearing loss was the commonest abnormality found and was present in 31% of CKD patients and 29% in control group. Middle frequency hearing loss was found in 8% of CKD patients and 6% in control group. Low frequency hearing loss was found in 7% of CKD patients and 6% in control group. Average hearing loss (<2000 Hz) was present in 8% of CKD patients and 7% in control group. (P-value >0.05).

Conclusion:
The hearing loss in patients with chronic kidney disease was higher than the age matched normal population though not statistically significant.

Key words: Chronic kidney disease, Pure tone audiometry, SNHL,

INTRODUCTION:
Many similarities exist between the nephron and the stria vasculares of the cochlea and hearing loss have been reported in patients with renal failure. Although the gross anatomy of the kidney and cochlea differ greatly, there are many similarities at the ultra-structural level. Both contain epithelial structures in close contact with their vascular supply. Basement membranes are found in Bowman’s capsule, the proximal renal tubule of the kidney and around the capillaries of the stria vasculares. In addition, basement membrane interlaced intercellular channels exist in both the glomerulus and the stria. Carbonic anhydrase is present in both the stria and nephron. The hereditary condition Alport’s syndrome comprises both renal pathology and progressive hearing loss. Furthermore it has been shown that there is an immunological connection between the kidney and inner ear in that antibodies raised against the nephron also deposit in the stria vasculares. Various pharmacological agents act on both the inner ear and kidney. Aminoglycoside antibiotics can be both nephrotoxic and ototoxic.

The National kidney foundation (NKF) kidney disease outcome quality initiative advisory board approved development of clinical practice guidelines to define “chronic kidney disease” and to classify stages in the progression of chronic kidney diseases. The work group defined chronic kidney disease to include conditions that affect the kidney, with the potential to cause either progressive loss in the kidney function or complications resulting from decreased kidney function.

The work group developed the following operational definition of chronic kidney disease:
1. Kidney damage for <3 months as defined by structural or functional abnormalities of the kidney, with or without decreased GFR, manifest by either pathological abnormalities or markers of kidney damage, including abnormalities in the composition of the blood or urine, or abnormalities in imaging tests.
2. GFR<60 ml/min/1.73m² for >3 months, with or without kidney damage.

Hearing threshold is generally defined as the lowest sound pressure at which under specified condition a person gives at least 50% correct detection of response. Pure tone audiometry is done to measure the hearing threshold for certain standardized stimuli via air conduction and bone conduction routes. Audiometric hearing loss may be defined as an average loss of greater than 25 decibels (dB) for the frequencies 0.5, 1 and 2 KHz. If bone conduction level is normal (within 20 db) with AB gap 20 db or more, then the deafness is said to be of conductive type. If bone conduction level is more than 20 db and AB gap is 15 db or less, then the deafness is said to be of sensory neural type. If bone conduction level is more than 20 db and AB gap is 20 db or more the deafness is called mixed type. The result of mean hearing loss is calculated at speech frequencies, i.e., between 500, 1000, 2000 Hz. Sensory neural hearing loss results from lesions of the cochlea, especially the hair cells of organ of corti, eighth nerve or central auditory pathways. It may be present at birth (congenital) or start later in life (acquired). Disorders of metabolism as well as endocrine disorders are reported to result in sensorineural hearing loss including the diabetes mellitus, hypothyroidism, hyperlipoproteinemia, renal failure, hyperuricemia, acromegaly, Addison’s diseases and pheochromocytoma. In adult patients with end stage renal disease, reported incidence of SNHL is about 20-87% which is much higher than the general population. Early detection of hearing loss makes the rehabilitation possible at the early stage. No studies have been done in the past to assess the hearing loss in patients with CKD in Nepal. The present study was done to explore the hearing status between the chronic kidney disease patients and age matched healthy controls.

MATERIALS AND METHOD:
This was a case control study conducted in the department of Otolaryngology and Head & Neck surgery and department of Internal Medicine, B.P. Koirala institute of Health Sciences, Dharan, between July 2007 to December 2008. Fifty consecutive CKD patients between age of 15 to 73 years without history of ear disease prior to CKD, without conductive hearing loss, without history of sensorineural hearing loss prior to development of CKD (due to other causes e.g. noise, infection) were included. Similarly fifty age (+/-5) matched normal population or surgical cases without any ear problems, any systemic illness related to chronic kidney diseases or hearing loss and any other known risk factors for hearing loss were taken in the study. Patients’ participants (case and control group) below five years were not included in this study because of their inability to interpret audiometry tones appropriately. Informed consent was taken from all participants. Ethical approval was taken from the ethical committee of the institute. Chronic kidney disease (CKD) diagnosed according to NKF/DOQI criteria. Detailed clinical history and physical examination including otological assessment was carried out in all the subjects according to Performa. Patients’ participants’ occupational history was taken to exclude risk factors for hearing loss e.g. noise exposure. Birth and developmental history was taken to exclude congenital and other causes of acquired hearing loss before the development of CKD.
Drug history was taken, especially the ototoxic drugs. Past history of ear trauma and head injury was taken into account in the prior hearing loss. Otological examination was carried out to exclude middle ear pathology. All the subjects had normal ears at otoscopy. Turning fork tests (Arm's, Weber's) were carried out with 512 Hz tuning fork which gave Rinne’s positive in sensory neural hearing loss. Weber test was done to detect the better hearing cochlea. We found positive Rinne’s test and Weber’s test was centralized in all the patients (case and control group). Pure tone audiometry was done on each patient/participant in a sound-proof room. Calibrated Italian diagnostic audiometer (Amploid-460) was chosen for study and tests performed by a trained audiometer. The audiometric testing was done by a single person to ensure test-retest reliability. No patients had air bone gap in the audiometric testing. The results are documented as low (250-500 Hz), middle (1000-2000Hz), and high (4000-8000Hz). Threshold for hearing was determined separately for each ear. We calculated the average of two responses in cases of doubt. Hearing threshold of cases were compared with those of control group. The collected data was entered into Microsoft Excel Spreadsheet and was analyzed using SPSS version 11.5. Mean and standard deviation of variables in both Group 1 and Group 2 were calculated. Student’s ‘t’ test was used for comparing cases with controls.

RESULTS:
Total of 100 subjects were included in our study. (Table 1) Mean age of CKD patients in Group 1 was 41.36 years (Range: 17-73 years). Mean age of Group 2 consisting of healthy controls was 43.26 years (Range: 20-77 years). The two groups were similar with respect to age. (No significant difference) (P-value 0.625). There were 24 (57%) females and 26 (43%) males in Group 1 while Group 2 consisted of 22 (53%) females and 25 (47%) males. The two groups were similar with respect to sex with no significant difference (P-value 0.688). There were ten patients (20%) in stage 2, seven (14%) patients in stage 3, seven patients (14%) in stage 4, twenty-six patients (52%) in stage 5 of chronic kidney disease. The mean duration of chronic kidney disease since detection was 27.86 months. (SD= 33.43) (range: 1-152 months). Out of 50 CKD patients, seven patients had diabetes mellitus, twelve had hypertension and fourteen had both diabetes mellitus and hypertension both as a comorbid illness. Fifteen patients didn’t have any known comorbid illness. Out of 50 patients, twenty-one patients had history of atenolol administration, ten patients had history of atenolol and frusemide administration, one patient had history of frusemide and amikacin administration and eighteen patients did not have any history of ototoxic drug administration. Two (4%) patients had history of renal transplantation. Twenty seven (54%) patients had history of dialysis and 23 (46%) patients did not have any history of dialysis. Sensory neural hearing loss was present in 46% of CKD patients (group 1) and 43% of normal population (group 2). High frequency hearing loss was the most common abnormality found and was found in 31% of CKD patients (group 1) and 29% of normal healthy population (group 2). Middle frequency sensory neural hearing loss was found in 8% of CKD patients (group 1) and 8% normal population (group 2). Low frequency hearing loss was found in 7% of CKD patients (group 1) and 6% normal population (group 2). Average hearing loss (<2000Hz) was present in 8% of CKD patients (group 1) and 7% normal population (group 2) (Table 6). Mean hearing loss in 52,000 Hz, 250-500 Hz, 1,000-2,000 Hz, 4,000-8,000 Hz frequency range were 18.53±13.91 dB, 18.23±13.74 dB, 18.75±14.11 dB and 39.66±28.96 dB in CKD patients (group 1) and 18.46±11.17 dB, 16.85±11.07 dB, 19.90±14.38 dB and 28.27±28.03 dB in control (group 2). (Table 7) Hearing loss in different audiometric frequencies in CKD patients (group 1) was higher than it was in control group. But the difference could not reach to a statistically significant level (P-value >0.05).

DISCUSSION:
Hearing loss has been observed in patients with chronic kidney disease. With this background, we conducted the present study to assess the hearing loss in patients with chronic kidney disease. There were fifty patients of CKD in our study. The patients were between 17 to 73 years of age. Mean age of patients was 41.36 years (SD ± 16.37 years, Range 17-73 years). There were 24 (48%) females and 26 (52%) males in patient group. There was similar age and sex distribution of the patients. Patients’ participants (case and control group) below five years were not included in our study. This study was similar in age and sex distribution to the study done by LP. Morton et al and D. Getland et al. We had taken all the CKD patients irrespective of the hemodialysis and renal transplantation. Our aim here was to assess

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Tab. 1: Age distribution

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>Group 1 CKD patients</th>
<th>Group 2 Control</th>
<th>Total</th>
<th>Total</th>
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<tr>
<td>Age(in years)</td>
<td>15-30</td>
<td>19</td>
<td>10</td>
<td>29</td>
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</tr>
<tr>
<td>31-45</td>
<td>8</td>
<td>12</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46-60</td>
<td>17</td>
<td>16</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>61-80</td>
<td>6</td>
<td>12</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>50</td>
<td>100</td>
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<td></td>
</tr>
</tbody>
</table>

Tab. 2: Sensory neural hearing loss in <2,000Hz frequency range

| Variable  | Category | Group 1 CKD Patients | Group 2 Control | Total | Total%
|-----------|----------|----------------------|----------------|-------|-------|
| Hearing Loss | 0-25dB | 42 | 43 | 85 | 85%
| 26-40dB | 6 | 5 | 11 | 11%
| 41-55dB | 1 | 1 | 2 | 2%
| 56-70dB | 0 | 1 | 1 | 1%
| 71-90dB | 0 | 0 | 0 | 0%
| >90dB | 1 | 0 | 1 | 1%
| Total | 50 | 50 | 100 | 100%

Tab. 3: Sensory neural hearing loss in 250-500Hz frequency range

| Variable  | Category | Group 1 CKD Patients | Group 2 Control | Total | Total%
|-----------|----------|----------------------|----------------|-------|-------|
| Hearing Loss | 0-25dB | 43 | 43 | 86 | 86%
| 26-40dB | 7 | 6 | 13 | 13%
| 41-55dB | 0 | 0 | 0 | 0%
| 56-70dB | 0 | 0 | 0 | 0%
| 71-90dB | 0 | 0 | 0 | 0%
| >90dB | 0 | 0 | 0 | 0%
| Total | 50 | 50 | 100 | 100%

Tab. 4: Sensory neural hearing loss in 1,000-2,000Hz frequency range

| Variable  | Category | Group 1 CKD Patients | Group 2 Control | Total | Total%
|-----------|----------|----------------------|----------------|-------|-------|
| Hearing Loss | 0-25dB | 42 | 42 | 84 | 84%
| 26-40dB | 6 | 4 | 10 | 10%
| 41-55dB | 1 | 0 | 1 | 1%
| 56-70dB | 0 | 2 | 2 | 2%
| 71-90dB | 0 | 1 | 1 | 1%
| >90dB | 1 | 1 | 2 | 2%
| Total | 50 | 50 | 100 | 100%

Tab. 5: Sensory neural hearing loss in 4,000-8,000Hz frequency range

| Variable  | Category | Group 1 CKD Patients | Group 2 Control | Total | Total%
|-----------|----------|----------------------|----------------|-------|-------|
| Hearing Loss | 0-25dB | 19 | 21 | 40 | 40%
| 26-40dB | 10 | 10 | 20 | 20%
| 41-55dB | 8 | 8 | 16 | 16%
| 56-70dB | 6 | 6 | 12 | 12%
| 71-90dB | 6 | 5 | 11 | 11%
| >90dB | 1 | 0 | 1 | 1%
| Total | 50 | 50 | 100 | 100%
Tab. 6: Sensory neural hearing loss in CKD patients and normal population

<table>
<thead>
<tr>
<th>Frequency</th>
<th>CKD Patients</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>4000-8000Hz</td>
<td>31%</td>
<td>29%</td>
</tr>
<tr>
<td>1000-2000Hz</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>250-500Hz</td>
<td>7%</td>
<td>6%</td>
</tr>
<tr>
<td>Total</td>
<td>46%</td>
<td>43%</td>
</tr>
<tr>
<td>Mean hearing loss(&lt;2000Hz)</td>
<td>8%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Tab. 7: Comparison of mean of hearing loss in CKD Patients (Group—1) with control (Group—2)

<table>
<thead>
<tr>
<th>Frequency</th>
<th>CKD Patients</th>
<th>Control</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 2,000 Means</td>
<td>18.93</td>
<td>18.46</td>
<td>0.853</td>
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<tr>
<td>(N=22) SD</td>
<td>13.91</td>
<td>11.17</td>
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<tr>
<td>250-500 Means</td>
<td>18.25</td>
<td>16.85</td>
<td>0.576</td>
</tr>
<tr>
<td>(N=8) SD</td>
<td>13.74</td>
<td>18.25</td>
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<tr>
<td>1,000-2,000 Means</td>
<td>18.75</td>
<td>19.60</td>
<td>0.766</td>
</tr>
<tr>
<td>(N=8) SD</td>
<td>14.11</td>
<td>14.38</td>
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<tr>
<td>4,000-8,000 Means</td>
<td>39.66</td>
<td>38.27</td>
<td>0.808</td>
</tr>
<tr>
<td>(N=8) SD</td>
<td>28.96</td>
<td>28.03</td>
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</table>

CONCLUSION:
The hearing loss in patients with chronic kidney disease was higher than the age matched normal population but was not statistically significant.

REFERENCES: