Indian J Otolaryngol Head Neck Surg
(October–December 2012) 64(4):356–359; DOI 10.1007/s12070-011-0405-5

ORIGINAL ARTICLE

Hearing Loss in Patients of Chronic Renal Failure: A Study of 100 Cases

Rakesh Singh Meena · Yogesh Aseri · B. K. Singh · P. C. Verma

Received: 12 August 2011 / Accepted: 24 November 2011 / Published online: 3 December 2011

Abstract The purpose of our study was to determine the incidence of hearing loss and to describe the hearing impairment and the possible contributing factors, responsible for sensori neural hearing loss in chronic renal failure (CRF) patients. This was a prospective study carried out on 50 cases of CRF attending otorhinolaryngological services for hearing disturbance and on 50 healthy volunteers for control study, having the same inclusion criteria except (does not suffering with CRF) having normal renal function tests. These volunteers attended the ENT OPD, for oto-rhino-laryngological services but not for hearing problems. 14 (28%) out of 50 cases of CRF had sensori neural hearing loss of moderate to severe degree in the high frequency range which was bilateral and symmetrical, while in control group the incidence of sensorineural hearing loss was only 6%.

Keywords Chronic renal failure (CRF) · Sensori neural hearing loss (SNHL) · Brainstem evoked response audiometery (BERA) · Oto acoustic emission (OAE) · Haemodialysis (HD)

Introduction

Presence of hearing loss and estimation of type and degree constitute one of the most common method used to investigate the effects of renal disease on the auditory system. The incidence of sensorineural hearing loss (SNHL) among patients with CRF is considerably higher than general population and varies from mild hearing disturbance found in 77% cases [1] to moderately severe hearing loss in 46% of the tested patients [2]. Most of hearing loss is in high frequency range with a notch at 6 kHz. The degree of hearing loss may give an indication of the extent of damage to auditory function whereas the type of hearing loss may distinguish between lesion in outer and middle ear (conductive hearing loss) or cochlea and the neural pathways (SNHL). This study was conducted to evaluate hearing loss in chronic renal failure (CRF) patients and to find the possible factors responsible for hearing loss, i.e., elevated serum urea, creatinine and serum electrolytes, number of haemodialysis and to correlate extent of hearing loss with duration of CRF and kidney size. The kidney size for every case was measured by ultrasonography (USG). The USG was preferred to measure the kidney size because it is least invasive and does not have any side effect. Small kidney size indicates long standing renal disease (e.g., contracted kidney presents in end stage renal disease), thus impaired renal functions. Although small kidney may be a normal variant but in that case the renal functions will be normal. Large kidney size usually presents in acute conditions (e.g., infection) which are reversible thus in case of large size of kidney, reversible impairment of function may occurs.

Materials and Methods

This is a prospective study carried out on 100 cases. Out of these 50 cases suffering with CRF and 50 cases were healthy volunteer, in the age range of 15–60 years, who

R. S. Meena (✉) · Y. Aseri · B. K. Singh · P. C. Verma
Jawahar Lal Nehru MedicalCollege, B 534, Panchsheel Nagar, Makadwali Road, Ajmer, Rajasthan, India
e-mail: rakeshmeenaent@yahoo.in

R. S. Meena · Y. Aseri · B. K. Singh · P. C. Verma
A.G. Hospitals, Ajmer, Rajasthan, India

attended the Departments of ENT and Medicine at Jawahar Lal Nehru Medical College and Hospital, Ajme (Rajasthan).

There were five criteria for cases selection (inclusion criteria): all five criteria were present in all 50 cases.

(1) age range of 15–60 years;
(2) hearing impairment after the occurrence of renal failure (elevated level of biood urea, serum creatinine with oliguria) which necessitated ENT referral;
(3) no history of noise exposure;
(4) no history diabetes; and
(5) no history renal transplantation.

Criteria for healthy volunteers were: (1) age range of 15–60 years; (2) normal renal function tests; (3) no history of noise exposure; (4) no history of diabetes; and (5) no history of renal transplantation.

Renal failure was diagnosed by elevated level of blood urea and serum creatinine and associated oliguria. Haemodialysis was done in 14 patients. An informed consent was taken from all the patients. A thorough clinical examination and a complete ENT check up was done. Other investigations like serum electrolytes (Na^+, K^+, Cl^-) and urine for protein (albumin) were also carried out. USG abdomen (for kidney size) was advised for every patient. Audiological examinations includes Tuning fork tests, Pure tone audiometery, Tympanometry and BERA and were done in all cases to describe the (type and extent) hearing loss.

Observations

In the study of control group of 50 healthy volunteers only 3 cases (6%) of 31–60 years age group had SNHL. Out of these only 2 cases were male and one was female. All the three cases had moderate SNHL of high frequency range.

All the healthy volunteers had their serum creatinine, blood urea, serum electrolytes level and kidney size with in normal limit and all having their systolic blood pressure <140 mmHg.

The CRF is found in all age groups, but its incidence varies with age (Table 1). Out of the total 50 cases of CRF 38 (76%) were males and 12(24%) were females. Thus, CRF is more commonly seen in age group of 31–45 years in males. In our study total 14 out of 50 (28%) patients had hearing loss (SNHL). Out of these 14 cases, 10 were males and 4 females.

Ten out of the 14 cases (71.42%) had undergone for haemodialysis; at least once (1 case), twice (2 cases), thrice (6 cases) and 4 times (1 case). Thus, 4 out of these 10 cases (40%) had a hearing loss of over 75 db and had undergone for HDs 3–4 times. In contrast only 4 out of 36 cases without SNHL had undergone for haemodialysis; once (1 case), twice (1 case) or thrice (2 cases). Thus, the degree of hearing loss correlated with the number of haemodialysis (HDs) as seen in the Table 2. The possible mechanism is haemodialysis induced changes in fluid and electrolyte composition of endolymph.

Table 1 Age and sex distribution of cases ($N = 50$) and healthy volunteer

Age range (years)	Cases of CRF (50)					Healthy volunteers (50)				
	SNHL		No SNHL		Total	SNHL		No SNHL		Total
	M	F	M	F		M	F	M	F	
15–30	2	3	7	5	17	–	–	8	6	14
31–45	5	1	16	2	24	2	–	15	8	25
46–60	3	–	5	1	9	–	1	6	4	11
15–60	10	4	28	8	50	2	1	29	18	50

The onset of hearing loss was sudden in two patients and gradual in remaining twelve patients. All the 14 patients of CRF with SNHL had moderately severe to severe degree of hearing loss.

As the number of haemodialysis (3–4) increases, the chances of developing SNHL and degree also increases.

The duration of CRF was related to the degree of SNHL and the relationship is shown in Table 3. Patients who were suffering with CRF from more than 3 years, had underwent for haemodialysis more frequently (10 out of 14). There is higher incidence of SNHL in patients with long standing CRF. As the duration of CRF progresses, patients become more prone to develop hearing loss. Out of 8 patients with SNHL of more than 70 dbs only 7 had CRF for more than 4 years and only one had the duration of less than 4 years. Such relationship was not observed in CRF without SNHL.

The serum electrolytes were measured in all the studied cases and the mean values are shown in the Table 4.

There was no difference in the level of serum electrolytes between the groups of patients with SNHL of 50–70 db and those without hearing loss. However, Patients with SNHL over 70 db had significantly low sodium and higher potassium and chloride values. This signifies the role of electrolyte disarray in causing SNHL.

Serum creatinine idicates the extent of renal damage. However, the results of this study (Table 5) shows that its

Table 2 Degree of hearing loss and haemodialyses (HD)

Hearing loss (dbs)	Number of cases according to HD number				
	Nil	I	II	III	IV
55–65	2	1	–	2	–
>65–75	–	–	2	1	–
>75–85	2	–	–	2	–
>85–90	–	–	–	1	1
Total ($n = 14$)	4	1	2	6	1

Table 3 Relationship between duration of CRF and degree of SNHL

Duration of CRF (years)	Number with SNHL					Number without SNHL	
	Degree of SNHL (db)				Number according to HDs		Number according to HDs
	50–60	>60–70	>70–80	>80–90			
1–2	–	–	–	–	–	9	2
2–3	2	–	–	–	–	11	1
3–4	–	2	–	1	4	8	–
4–5	–	1	3	2	4	7	1
5–6	–	1	1	1	2	1	–

Table 4 Serum electrolytes in patients with CRF with and without SNHL

Electrolyte (mEq/l)	With SNHL (Mean ± SD)		Without SNHL (Mean ± SD)
	50–70 db	71–90 db	
Sodium	133.5 ± 2.6	127.7 ± 5.6*	133.1 ± 7.8
Potassium	5.2 ± 0.9	6.8 ± 0.7*	5.4 ± 0.9
Chloride	102.3 ± 1.9	107.1 ± 4.1*	104.9 ± 3.8

$P < 0.05$ significant versus (50–70 dbs)

Table 5 Relationship between creatinine levels and SNHL

Serum creatinine (mg%)	Number according to SNHL	Number without SNHL
1.0–2.0	1	1
2.0–4.0	3	4
>4.0–6.0	–	3
>6.0–8.0	2	5
>8.0–10.0	1	8
>10.0–12.0	3	7
>12.0–14.0	3	6
>14.0–16.0	1	2
Mean ± SD	8.87 ± 4.58	9.43 ± 3.51

Normal serum creatinine level is up to 1.5 mg %

levels are similarly raised in cases of CRF with or without SNHL. Therefore, it cannot predict the occurance of SNHL (Table 6).

Blood Pressure

All the patients of CRF having raised BP but the all the patients suffered from SNHL had BP >160 mmHg (systolic). There is no clear relationship between diastolic BP and occurrence of SNHL.

Blood Urea

All patients of CRF with SNHL having raised blood urea level but number of patients does not increases with the increasing level of blood urea.

Table 6 Proteinuria in CRF patients

Urine albumin	Cases (50)	Percentage
1+	9	18
2+	18	36
3+	16	32
4+ and above	7	14
Urine albumin	Cases with SNHL (14)	Percentage
1+	–	–
2+	7	50
3+	5	35.5
4+	2	14.3

This table shows presence of proteinuria among patients suffering from CRF

All the patients of CRF with SN hearing loss had 2+ and more proteinuria

Kidney Size in Patients

All the patients (50) had decreased kidney size [in 33 (66%) cases both kidney and in 17 (34%) cases single kidney].

All the patients who had SN hearing loss (14) also had decreased kidney size [in 10 (71.4%) cases both kidney and in 4 (28.6%) cases single kidney].

Discussion

The cochlea and kidney have similar physiological mechanism namely the active transport of fluid and electrolytes accomplished by the stria vascularis and glomerulus respectively [2, 5]. These may also have common antigenicity [6, 7]. These may accounts for similar effects of medications (i.e. nephrotoxic and ototoxic effects of aminoglycosides) and immunological factors on two organs. Inner ear and kidney development are both influenced by similar genetic factors in hereditary conditions such as alport's syndrome and branchio-oto-renal syndrome.

Several aetiological factors have been linked to hearing loss in renal failure [4, 8] including use of ototoxic medications, electrolyte disturbances, hypertension [9, 10] and haemodialysis treatment itself [1, 3, 11, 12]. Brookes [13] suggested that vitamin-D deficiency might be a contributing factor to hearing loss in renal failure. Alder et al. found a significant reduction of Na^+, K^+ activated ATPase in the inner ear of uremic guinea pigs. They also reported an inverse correlation between serum creatinine levels and Na^+, K^+ activated ATPase. As the Na^+, K^+ activated ATPase in the cochlea is important for maintaining cationic gradients, they suggested that inhibition of this enzyme system may be a contributing factor in inner ear dysfunction among uremic patients [14]. Treatment evolution may have modified the contribution of several factors in causing hearing loss. For example hyponatremia was a common occurrence three decades ago [10], but it is no longer concern with newer haemodialysis methods.

From above observations and results the positive factor which could be a cause of hearing loss in CRF patients was long duration of renal failure. Finally it can be said that hearing loss (SNHL type) occurs in patients with CRF is not of genetic origin. This happened even after exclusion of known risk factors, like noise exposure, ototoxic drugs, head injuries etc. The presence of additional factors accelerate the cause of hearing loss. The presence of electrolyte imbalance, hypertension, proteinuria, haemodialysis are some of the factors which seems to have cumulative effect on deterioration of hearing in patients who were suffering with CRF.

Conclusion

In the present study of 50 cases (38 were male and 12 were females) only 14 (10 male, 4 female) patients had SNHL.

In CRF patients 28% (14) had SNHL as compared to 6% (3) in healthy volunteers thus there is higher incidence of SNHL in CRF patients.

All the patients had SNHL of moderately severe to severe degree in high frequency range, which was bilateral and symmetrical.

The incidence and degree of hearing loss were increases with the number of haemodialysis.

Patients with SNHL over 70 dB had significantly low sodium and higher potassium and chloride value.

All the 14 patients who had SNHL had long duration of renal failure and all had hypertension.

All the 14 patients with SNHL had been suffering with 2+ and more proteinurea.

Out of 14 patients, 10 had bilateral decrease in kidney size and 4 had unilateral decrease in kidney size (small kidney size).

All 14 patients of SNHL had systolic blood pressure >160 mm Hg but no clear relationship with diastolic BP.

The increase level of serum creatinine and blood urea can not predict the occurrence of hearing loss.

So it can be concluded from the study that patients suffering from long standing renal failure (long duration) had more chances of hearing loss than the healthy volunteers and there is cumulative effect of other risk factors such as haemodialysis, electrolyte imbalance, hypertension, proteinurea on SNHL in CRF patients. Hearing loss is becoming increasingly evident, as the patients tends to live longer because of improved quality of life of CRF patients. The raised blood urea level, serum creatinine level, and decrease kidney size does not predict the occurrence of SNHL.

References

1. Bazzi C, Venturini C, Arrigo GD, Amico G (1995) Hearing loss in short and long term haemodialyzed patients. Nephrol Dial Transpl 10:1865–1868
2. Ozturan O, Lam S (1998) The effect of hemodialysis on hearing using pure tone audiometery and distortion product otoacoustic emission. ORLJ of Oto Rhino lary 60:306–313
3. Johnson DW, Wathen RL, Mathog RH (1976) Effects of hemodialysis on hearing threshold. ORLJ Oto Rhino lary 38:129–139
4. Antonelli A, Bonfiolii F, Garrubbaa V et al (1991) Audiological findings in elderly patients with chronic renal failure. Acta Otolaryngologica 476(Suppl):54–68
5. Arnold W (1984) Inner ear and renal diseases. Ann Oto Rhino Lary 112(Suppl):119–124
6. Quic CA, Fish A, Brown C (1973) The relationship between cochlea and kidney. Laryngoscope 83:1469–1482
7. Arnold W (1975) Experimental studies in the pathogenesis of inner ear disturbances in renal diseases. Arch Otorhinolaryngol 211:217
8. Bergstrom L, Jenkins P, Sando I, English G (1973) Hearing loss in renal disease: clinical and pathological studies. Ann Oto Rhino lary 82(Suppl):555–574
9. Gartland D, Tucker B, Chalstrey S, Keene M, Baker L (1991) Hearing loss in chronic renal failure–hearing threshold changes following hemodialysis. J Roy Soc Med 84:587–589
10. Yassin A, Badry A, Fatthi A (1970) The relationship between electrolyte balance and cochlear disturbances in cases of renal failure. J Laryngol Otol 84:833–843
11. Hutchson J, Klodd D (1982) Electrophysiological analysis of auditory, vestibular, and brainstem function in chronic renal failure. Laryngoscope 92:833–843
12. Serbetcioglu B, Erdogan S, Sifil A (2001) Effects of a single session of hemodialysis on hearing abilities. Acta Otolaryngol 121:836–838
13. Brookes GB (1985) Vitamin D deficiency and deafness: 1984 update. Am J Otol 6:102–107
14. Alder D, Fiehn W, Ritz E (1980) 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 90:55–60