

Original Research Article

Correlation between serum electrolyte levels and brain stem evoked response audiometry in chronic renal failure: a pilot study

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Received: 08 September 2020

Accepted: 14 October 2020

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ABSTRACT

Background: The effect of electrolyte imbalance on hearing thresholds and its objective manifestation, as delayed latencies or inter-peak intervals in evoked response audiometry is studied.

Methods: The present prospective study was undertaken in a period of one and a half years, to analyze the audiological profile in patients of chronic renal failure and renal allograft recipients. 60 patients were randomly selected from the out-patient and indoor services of nephrology, urology and oto-rhino-laryngology, Dayanand Medical College and Hospital, Ludhiana. Brain stem evoked response audiometry was performed and the latencies were tabulated.

Results: A significant delay in the absolute latency of wave V was noted in hyponatremic patients of CRF on comparison with patients of CRF having a normal serum Na⁺ levels. The I-V interpeak interval was also seen to be significantly delayed on comparison. A statistically significant delayed I-III inter-peak latency was also observed in hypernatremic patients in comparison to patients having a serum Na⁺ level in the normal range. No significance of serum creatinine levels and wave latencies was noted on comparison between the three categories of patients of CRF as categorized by their serum creatinine levels.

Conclusions: There is a definite deterioration of the audiological function in patients of chronic kidney disease, and some reversal of these abnormalities following a successful renal transplantation; indirectly pointing towards uremic milieu being the culprit.

INTRODUCTION

The audiological profile in patients of chronic renal failure is altered, consequent to shifts in the electrolytes maintaining the milieu interior of intra-labyrinthine and peri-labyrinthine fluids.

Hearing impairment may not manifest clinically but is noted on brain stem evoked response audiometry. The effect of electrolytes, sodium, urea, potassium, creatinine etc is on the threshold, latency and inter-peak intervals in brainstem evoked response audiometry (BERA).

It has been documented that the relationship between electrolyte balance and cochlear disturbances in cases of renal failure and the degree of hearing loss is directly related to the degree of hyponatremia, irrespective of the level of blood urea.¹ Dialysis and renal transplant are likely to reverse these shifts.

Aim

Aim was to study the audiological profile in patients of chronic renal failure on evoked audiometry and to see effect of electrolytes on the parameters of BERA.

METHODS

The present study was undertaken to analyze the audiological profile in patients of chronic renal failure and renal allograft recipients. Total 60 patients were randomly selected from the out-patient and indoor services of Nephrology, Urology and Oto-rhinolaryngology, Dayanand Medical College and Hospital, Ludhiana. The prospective case control study was undertaken in a period of one and a half years (June 2008-December 2009). The patients were grouped as per the stage of chronic renal failure as under:

Study group 1 (n=20): patients of chronic renal failure managed conservatively. 10 patients of mild chronic renal failure~ (GFR-30-50 ml/min) and 10 patients of moderate and severe chronic renal failure (GFR-15-29 ml/min).

Study group 2 (n=20): patients with advanced chronic renal failure (GFR<15 ml/min) who had been taken up on the renal transplant program at Dayanand Medical College and Hospital, Ludhiana. These patients were evaluated both pre-operatively and post-operatively.

Control group 3 (n=20)

Inclusion criteria

Inclusion criteria were, 1) patients of chronic renal failure (mild, moderate and severe) 2) patients taken up for renal transplant (Advanced CRF).

Exclusion criteria

Exclusion criteria were, 1) age over 50 years as there is interference of age, dependent hearing loss (presbycusis) with that of the changes in chronic renal failure 2) history of ear discharge, noise trauma and repeated upper respiratory tract infections 3) the role of extraneous factors affecting brainstem evoked response and central nervous system derangements like hepatic diseases, cerebro-vascular accidents (CVA) and heart failure 4) history of diabetes.

BERA was performed in all the three groups and the latencies and inter peak intervals WRT wave V and, I-III were noted.

Statistics

All statistical calculations were done using Statistical Package of Social Sciences (SPSS) 17 Version statistical program for Microsoft windows (SPSS Inc. released 2008. SPSS statistic for windows, version 17.0, Chicago). Ethical approval of the study was taken from the Institutional Ethics Committee.

RESULTS

In the present study, no significance was found between the serum levels of Na⁺ or creatinine and the hearing loss.

Table 1: Statistical relation between serum creatinine levels and hearing thresholds in CRF patients.

Freq (KHz)	<5 (n=13)	5.1-10 (n=14)	>10 (n=13)	A vs B (t value)	B vs C (t value)	A vs C (t value)
0.25	12.50±4.894	9.82±5.231	9.80±3.744	1.375	0.008	1.576
0.5	13.26±4.719	10.89±4.45	10.96±3.891	1.344	0.043	1.360
1	14.23±5.142	12.50±7.84	10.96±4.274	0.682	0.639	1.762
2	15.19±4.728	17.14±9.70	13.65±4.160	0.672	1.230	0.882
4	18.46±5.257	23.92±13.36	17.69±4.943	1.417	1.630	0.384
8	30.384±7.489	35.71±18.84	26.53±11.57	0.978	1.536	1.006

Table 2: Statistical correlation between serum creatinine levels and BERA findings in patients of chronic renal failure.

Wave latencies	<5 (n=13)	5.1-10 (n=14)	>10 (n=13)	A vs B (t value)	B vs C (t value)	A vs C (t value)
I	1.78±0.101	1.840±0.096	1.88±0.137	1.501	0.807	1.990
III	3.97±0.226	4.06±0.187	4.07±0.174	1.110	0.158	1.264
V	5.75±0.100	5.87±0.274	5.78±0.274	1.570	0.927	0.406
I-III	2.16±0.148	2.25±0.182	2.20±0.132	1.461	0.854	0.630
III-V	1.81±0.218	1.77±0.239	1.73±0.250	0.500	0.435	0.934
I-V	3.95±0.094	4.02±0.276	3.93±0.253	0.997	0.953	0.254

In the present study, a significant delay in the absolute latency of wave V was noted in hyponatremic patients of

CRF on comparison with patients of CRF having a normal serum Na⁺ level (Table 1).

The I-V interpeak interval was also seen to be significantly delayed on comparison. A statistically significant delayed I-III interpeak latency was also observed in hypernatremic patients on comparison with patients having a serum Na⁺ level in the normal range. No significance of serum creatinine levels and wave latencies was noted on comparison between the three categories of patients of CRF as categorized by their serum creatinine levels (Table 2).

DISCUSSION

Hearing loss and electrolyte changes

In the present study, no significance was found between the serum levels of Na⁺ or creatinine and the hearing loss. Yassin et al 1970 while noting the relationship between electrolyte balance and cochlear disturbances in cases of renal failure showed the degree of hearing loss to be directly related to the degree of hyponatremia irrespective of the level of blood urea.¹ Some renal patients showed auditory changes within one dialysis period, but analysis of such parameters as BUN, creatinine, Na, K, Ca, glucose, mean BP and weights as evaluated just prior to and just after dialysis demonstrated no obvious relationship to changes in hearing levels Johnson and Mathog.²

Pandhi, Agarwal, Mehra et al noted a significant correlation between the Na levels and the impairment of hearing at frequencies ranging from 500 Hz to 8000 Hz which was reversible on correction of hyponatremia.³ No correlation was noted between the plasma osmolarity and the hearing impairment Kusakari, Kobayashi et al 1981 in a study of 229 patients on haemodialysis noted no correlations between the occurrence rate of the inner ear dysfunction and haematocrit, BUN and serum creatinine levels.⁴

Gattand, Tucker et al noted no correlation of hearing loss with weight changes, haematocrit; metabolic bone disease or ototoxic drug history in a study of 66 patients.⁵ Bazzi, Venturini et al noted no correlations between hearing loss and plasma creatinine and PTH values.⁶

Agarwal could establish no relationship between the level of blood urea, creatinine, serum potassium, serum calcium and blood pressure with the severity of impaired hearing. A direct correlation was seen between increasing hyponatremia and impaired hearing.⁷ Thus our study is in consensus with studies by Johnson and Mathog, Kusakari, Kobayashi, Gattand, Tucker and Bazzi, Venturini et al.^{4-6,8}

BERA and electrolyte changes

In the present study, a significant delay in the absolute latency of wave V was noted in hyponatremic patients of CRF on comparison with patients of CRF having a

normal serum Na⁺ level. The I-V interpeak interval was also seen to be significantly delayed on comparison. A statistically significant delayed I-III interpeak latency was also observed in hypernatremic patients on comparison with patients having a serum Na⁺ level in the normal range. No significance of serum creatinine levels and wave latencies was noted on comparison between the three categories of patients of CRF as categorized by their serum creatinine levels.

Pratt, Brodsky et al noted a correlation between creatinine and sodium levels with peak V latency in patients undergoing dialysis. The strongest correlation was noted between calcium levels and peaks I, III and V.⁹

Fan and Jiang et al correlation analysis revealed no consistent relationships between plasma proteins, hemoglobin, urea, creatinine, serum electrolytes and BAEP pL or IPL.¹⁰ The BAERs of 87 patients with chronic renal failure (average age 51 years) were examined according to serum creatinine levels, the nature of the chronic renal disease present and the effect of dialysis wave V latencies and the interpeak interval for waves I-V showed a correlation to serum creatinine levels.¹¹ Our study is thus in agreement with the study by Pratt, Brodsky et al.⁹

CONCLUSION

A definite deterioration of the audiological function in patients of chronic kidney disease, and some reversal of these abnormalities following a successful renal transplantation; indirectly pointing towards uremic milieu being the culprit. In the present study, we found no significant correlation between the serum levels of sodium or creatinine and the hearing loss. In CRF patients with hyponatremia a significant delay in the absolute latency of wave V along with a delay in the I-V interpeak interval, in hypernatremic patients statistically significant delayed I- III interpeak latency was noted.

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: Munjal M, Singh K, Chopra P, Munjal S, Chopra H, Mathur A, et al. Correlation between serum electrolyte levels and brain stem evoked response audiometry in chronic renal failure: a pilot study. *Int J Otorhinolaryngol Head Neck Surg* 2020;6:2050-3.