Indian J Physiol Pharmacol 2011; 55 (1) : 67–71

SHORT COMMUNICATION

VARIABILITY IN SERUM ELECTROLYTES IN DIFFERENT GRADES OF DEPRESSION

ANAND KUMAR SINGH*, PUNAM VERMA*, SUSHMA GUPTA** AND JALAJ SAXENA***

Department of Physiology
**SGRRIM & HS, Dehradun,*
***Era's Medical College, Lucknow*
****GSVM Medical College, Kanpur*

(Received on March 4, 2010)

Abstract : The present study was planned to assess the variation in serum electrolytes in patients of major depression. A total of 100 patients of 35–45 yrs of age (68 males and 32 females) of depression were compared with the age matched healthy volunteers. Severity of depression was assessed by DSM IV criteria and were graded into mild, moderate and severe depression. In all the subjects serum electrolytes (Na^+, K^+, Mg^{++} and Ca^{++}) were assessed quantitatively. All the depression patients were having higher level of Na^+, K^+, and Ca^{++} and lower level of Mg^{++}. Multivariate analysis showed that different grades of depression influences statistically significantly levels of serum Mg^{++} and Ca^{++} ($F_{2,98}$ for Mg^{++} = 4.88, P value = 0.001 and $F_{2,98}$ for Ca^{++} = 5.97, P value = 0.004). No statistically significant difference was observed for Na^+ and K^+ although their values were higher (within normal limit) in comparison to that of control group. Multiple comparison revealed highly statistically significant difference between the levels of serum Ca and Mg individually between mild and moderate depression ($S\ V_{(mild\ \&\ mod)}$ for Ca^{++}; Mg^{++} = 7.1; 7.4) moderate & severe depression ($S\ V_{(mod\ \&\ severe)}$ for Ca^{++}; Mg^{++} = 6.82; 6.92) and mild & severe depression patients ($S\ V_{(mild\ \&\ severe)}$ for Ca^{++}; Mg^{++} = 7.46; 7.73) with critical value = 6.36. These results indicated the disbalance in the level of serum electrolytes especially of Ca and Mg in accordance with the severity of depression.

Key words : electrolytes depression mild moderate severe depression

INTRODUCTION

Incidence of depression is increasing day by day due to competitive life style of the modern society and a tendency to achieve the best. World Health Report (WHR 2001) estimated that there are about 121 million people world wide suffering from depression. Depression is the type of mood disorder in which there is one or more episodes of

*[1]Corresponding Author : Dr. Anand Kumar Singh, Assistant Professor, Department of Physiology, SGRRIM & HS, Patel Nagar, Dehradun – 248 001 (UK)

depressed mood or loss of interest for at least two weeks duration accompanied by at least four additional symptoms of depression i.e. change in appetite, weight, sleep and psychomotor energy, feeling of worthlessness, difficulty in thinking and making decisions etc (1).

According to WHO classification, depression can be classified into mild, moderate and severe, depending on the existence of the number of symptoms, severity of the symptoms and the degree of impairment. Major electrolytes Na^{+}, K^{+}, Mg^{++} and Ca^{++} are involved in transmission of impulses related to neurons in CNS (2). Thus, the role of imbalance of body serum electrolytes has been linked to etiopathogenesis of depression (3, 4). As the critical role played by ion exchange mechanisms in neuronal function, including the metabolism and the release of monoamines implicated in the pathophysiology of affective disorders and also conflicting reports of serum electrolytes in different grades of depression, it seems relevant to measure the level of the main electrolytes (Na^{+}, K^{+}, Mg^{++} and Ca^{++}) in depression.

MATERIALS AND METHOD

The study was conducted in the psychiatry outpatient department of Lala Lajpat Rai Memorial and Associated hospital, Kanpur. The present study included 100 patients of 35–45 yrs of age (68 male & 32 female patients) of major depression of unipolar type according to DSM IV criteria (5). The age matched control group included 40 healthy volunteers (23 male and 17 female subjects) mainly from the staff of the LLR & Associated Hospital Kanpur.

Severity of depression was assessed by DSM IV criteria and ICD-10 and Hamilton rating scale and were graded into mild, moderate and severe depression (4). Only those patients were included for the study who were diagnosed with the illness for the first time and yet to receive any treatment (as antidepressants can alter serum electrolytes). There were 14 mild, 29 moderate and 57 severe grade depression patients.

Patients with hypertension, diabetes mellitus, liver & renal disease or having any narcotic drug abuse excluded from the study. Prior to the withdrawal of blood sample a careful history was taken and examination was done in every patient and then classified into mild, moderate and severe cases according to the criteria laid by International classification of disease (ICD-10) by WHO and by using Hamilton rating scale (6, 7). Blood sample in all the cases were drawn between 10 am to 12 am. Serum was separated after double centrifuging at 1200 & 800 rpm for 8 min and 12 min respectively in the department of biochemistry in Laxmipati Singhania Institute of Cardiology, GSVM Medical College, Kanpur.

For quantitative determination of serum Mg^{++} 'Calmagite dye' method was used (8) and for Ca++ 'Cresolphthalein Complexone' method was used. Serum Na^{+} and K^{+} concentration were estimated by Flame Photometry (Medi flame 127).

The study was approved by Ethical Committee and a written informed consent was received from each subject.

RESULTS

The mean age of the control subjects was

41.65±7.97 yrs and that of patients was 39.65±7.00 yrs.

Depression patients had higher levels of Na^+, K^+ & Ca^{++} and lower level of Mg^{++} in comparison to the controls (Table I). Multivariate analysis showed that different grades of depression were influenced statistically significantly the level of serum Mg^{++} and Ca^{++} ($F_{2,98}$ (Mg^{++}) = 4.88, P value = 0.01; $F_{2,98}$ (Ca^{++}) = 5.97, P value = 0.004) in male and female subjects.

On the other hand statistically significant effect could be observed with the levels of serum Na^+ & K^+ although the values were more in comparison to controls but these were within the normal range. The rise was in accordance to the severity of the depression.

On multiple comparison by Scheffe's method (9) highly statistically significant difference in the level of serum Ca^{++} and Mg^{++} were found individually between mild and moderate depression ($SV_{(mild\ \&\ mod)}$ for Ca^{++}; Mg^{++} = 7.1; 7.4) moderate and severe depression ($SV_{(mod\ \&\ severe)}$ for Ca^{++}; Mg^{++} = 6.82; 6.92) and mild and severe depression patients ($SV_{(mild\ \&\ severe)}$ for Ca^{++}; Mg^{++} = 7.46; 7.73) with critical value = 6.36.

The patients suffering from severe depression had lowest serum magnesium level in both sexes. The patients suffering from severe depression had higher serum Ca^{++} levels as compared to those suffering from mild depression. These changes were observed in both sexes.

The serum potassium levels were lower in patients suffering from mild depression in both sexes higher potassium levels than control were seen in patients suffering from severe depression. This change was observed in patients of both sexes.

Changes in serum sodium levels were marked in female patients of depressions as compared to their male counter parts. There were rise serum sodium levels as compared to control group and this rise was parallel to degree of depression being highest in female patients suffering from severe depression.

DISCUSSION

Few reports have been obtained concerning to the plasma concentration of either K^+ or Na^+ in depressed patients. Frazer et al and Widmer J et al (1983) showed a small increase in Na+ in major depression

TABLE I : Serum electrolytes in depression.

Subjects	*Serum electrolytes*			
	Na^+ (meq/l)	*K^+ (meq/l)*	*Mg^{++} (mg/dl)*	*Ca^{++} (mg/dl)*
Control (n=40)	141.94±1.94	3.65±0.26	2.7±0.26	10.22±0.21
Patients (n=100)	142.46±1.68	3.70±0.19	1.09±0.24	11.6±0.38
Mild (n=14)	142.78±1.76	3.54±0.32	1.47±0.13	10.79±0.32
Moderate (n=29)	141.89±1.76	3.66±0.13	1.21±0.08	11.53±0.22***
Severe (n=57)	142.68±1.58	3.75±0.15	0.91±0.13***	11.79±0.21

patients (10, 11). Similarly in the present study, Na^+ and K^+ level were also found higher than the control group but within normal limit (12). This finding can be supported by the study of Bruinvels et al (1975) who clearly indicated direct involvement of divalent ions Ca^{++} and Mg^{++} in increased uptake of catecholamine precursor like L-tryptophan particularly in the normal level of Na^+ and thus secondarily catecholamines could be the causative factor in the depression (13, 14).

The higher normal K^+ level, as found in this study, may also be due to decreased Mg^{++} level, because Mg^{++} are implicated in Na^+ and K^+ permeability and the stability of the internal molecular arrangement of the cellular membrane. Thus, decrease in Mg^{++} consequently may alter the membrane permeabilities of K^+ (15).

This study also found out significantly low Mg^{++} level in depression patients which was linked with severity of depression (16). While other reports mentioned increased Mg^{++} level in highly depressed patients which is contrary to our findings of decreased Mg^{++} levels. The reason might be linked to long standing depression in cases of other reports in comparison to this study (17). Mg^{++} modulate and control cell Ca^{++} entry and Ca^{++} release from the sarcoplasmic and endoplasmic reticular membranes and the dietary deficiency of Mg^{++} was found to be the cause of low K^+ and high Na^+ and Ca^{++} which might be the fact that the patients as our results more or less are same but the dietary aspects of these ions needed to be explored (18, 19).

Thus change in the ion levels found in the present study could be due to dependence of distribution changes of these ions in the different phases of depressive illness and also due to the weakness of ATPase which transport these cations through the cell membrane (20). Clearcut disbalance in the level of Mg^{++} and Ca^{++} in the present study prove importance of Mg^{++} and Ca^+ in the pathophysiology of major depression (21). Besides these, Na^+ and K^+ levels are also altered with increasing severity of depression indicating that the disorders of Na^+ and K^+ metabolism might also play role in the pathophysiology of depression.

REFERENCES

1. Kraepelin. Short Text Book of Psychiatry by Niraja Ahuja V edition Appendix II 2002.
2. Levine J, Stein D, Rapoport A, Kutzman L High serum and cerebral spinal fluid Ca/Mg ratio in recently hospitalized acutely depressed patients. *Neuropsychobiology* 1999; 39: 63–70.
3. Kamei K, Tabata O, Muneoka K, Muraoka SI, Tomyoshi R, Takigawa M. Electrolytes in erthrocytes of patients with depressive disorders *Psychiatry Clin Neurosci* 1998; 52: 529–33.
4. Pathak SK, Gaur RK, Saxena J, Singh PN. Unipolar depression and serum electrolyte. *IJPP* 2000; 44: 503–505.
5. Diagnostic and statistical manual of mental disorders, IV edition Text revision 2000.
6. ICD-10 http://www.who.int/classifications/icdten.
7. Hamilton M A. Rating scale for depression. *Journal of Neurology, Neurosurgery and Psychiatry* 1960; 23: 56–62.
8. Ginder EM, Heth DA. Calorimetric determination with bound ‘calmagite dye’ of magnesium in human blood serum. *Clin Chem* 1971; 17: 662.
9. Madelon A, Barbara HM. Differences among group means: One way analysis of variance. In Barbara HM, Madelon AV, Ellis BP eds.

Statistical methods for health care research Lipponcott Company 1986; 174–199.

10. Frazer A, Ramsey TA, Swann A, Bowden C, Brunswick D, Garver D, Secunda. S Plasma and electrolytes in affective disorders. *J Affect Disord* 1983; 5: 103–113.

11. Ramsey TA, Frazer A, Mandels JL. Plasma and erythrocyte cations in affective disorders. *Neuropsychobiology* 1979; 5: 1–10.

12. Widmer J, Bovier P, Karege F, Raffin Y, Hilleret H, Tissol R Gaillard JM. Evolution of blood magnesium, sodium, and potassium in depressed patients followed for three months. *Neuropsychobiology* 1995; 26: 173–179.

13. Bruinvels J. Effects of sodium in neuronal uptake of monoamines and amino acid precursors. *Nature* 1975; 16: 606–607.

14. Khoury EL, Petterson U, Kallner G, Aberg-Wistedt A, Stain-Malmgren R. Calcium homeostasis in long-term lithium-treated women with bipolar affective disorder./Vog *Neuropsychopharmacol Biol Psychiatry* 2002; 26(6): 1063–1069.

15. Hoffman JF, Tosteson DC. Presented at the meeting of Biophysical society Pittsburgh 1959.

16. Carney MW, Scheffield BF, Sebastian J. Serum magnesium, diagnosis, ECT and season. *British J Psychiatry* 1973; 122: 427–429.

17. Linder J, Brismar K, Beck Fiis J, Saaf J, Weterbergh L. Calcium and magnesium concentrations in affective disorder : Difference between plasma and serum in relation to symptoms. *Acta Psychiatr Scand* 1989; 800: 527–537.

18. Altura BM, Altura BT. Role of magnesium in pathophysiological processes and the clinical utility of magnesium ion selective electrodes. *J Clin Lab Invest Suppl* 1996; 224: 211–234.

19. Torres SJ, Nowson CA, Worsley A. Dietary electrolytes are related to mood. *Br J Attrition* 2008 Nov; 100(5): 1038–1045.

20. Rybakowski J, Jankowiak E. Plasma and erythrocytes in endogenous depression Neurophysiologic implications. *Psychiatr Pol* 1989; 23: 265–270.

21. Eby GA, Eby KL. Rapid recovery from major depression using magnesium treatment. *Med Hypotheses* 2006; 67(2): 362–363.