ORIGINAL RESEARCH PAPER

Volume-7 | Issue-5 | May-2018 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ELECTROLYTE AND ELECTROCARDIOGRAPHIC CHANGES IN PROTEIN ENERGY MALNUTRITION

Pediatrics

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ABSTRACT

BACKGROUND: Several metabolic derangements and electrocardiographic changes occur in protein energy malnutrition (PEM) which increases the morbidity and mortality in these patients.

METHODS: This was a prospective observational study conducted at tertiary pediatric hospital in north India. Total of 75 patients were enrolled as cases (with PEM) and 75 age and sex matched controls were taken without PEM. The electrolyte and ECG findings were recorded at the time of admission and compared with the controls.

RESULTS: There was significantly decreased serum sodium, potassium and calcium levels in PEM as compared to controls ($p<0.001$). Prolongation of PR interval and QTc interval was significant in severe PEM as compared to controls ($p<0.001$).

CONCLUSION: Dyselectrolytemia and electrocardiographic changes are common in patients with severe malnutrition which needs urgent attention for appropriate management.

KEYWORDS

malnutrition, electrolytes, electrocardiographic

INTRODUCTION;

Protein-energy malnutrition (PEM) is a major public health problem in the low middle income countries. It is the most common nutritional disorder affecting children in developing countries. It mainly involves under 5 year age children resulting in increased morbidity and mortality. It is often caused by protein and/ or energy deficiency due to inadequate nutrition, superadded infections, poor socio economic and environmental conditions. PEM can alter immune function, growth and development of children, their learning ability, social and behavioral development. It can also hamper their work efficiency and productivity of labour. [1] The spectrum of PEM varies from mild to severe form. The severe form of PEM are Kwashiorkar, marasmus and marasmic kwashiorkor. Infact this severe form represent only the tip of ice berg.

The PEM is associated with several metabolic abnormalities and cardiologic derangements, which needs to be identified and managed on urgent basis. There could be abnormalities related to total body water, sodium, potassium and calcium levels. Serum sodium and potassium levels decrease with severe malnutrition. [2] Children with malnutrition, regardless of its type, has a definite effect on cardiac volume, muscle mass, as well as the electrical properties of the myocardium. The children may manifest with congestive cardiac failure due to severe PEM. There could be associated heart rate abnormalities, QRS axis , PR interval, QTc interval and ST segment changes with PEM. The systolic functions of the heart are affected more than the diastolic functions and this affection becomes manifest only in severe cases of PEM. [3] Early detection and management of these metabolic derangement can prevent significant morbidity and mortality in these patients. With this background we plan to study the electrolyte and ECG changes in PEM children < 5 years old.

METHODS

The present study was conducted at a tertiary level pediatric hospital in north India. This was a prospective observational study where children of age group 6 months to < 5years of age were enrolled into the study after informed consent from the parents between June 2005 to May 2006. The patients of this age group were classified as per the Indian academy of Pediatric classification of PEM into 5 categories (No PEM= weight/age >80% of expected; grade I PEM= weight/age 70-80% of expected; Grade II PEM= weight/age 60-70% of expected; Grade III PEM= weight/age 50-60% of expected; Grade IV PEM= weight/age <50% of expected). The Patients with Grade I to IV PEM were enrolled as cases and patients with No PEM were enrolled as controls after being matched for age and gender. These cases had either primary malnutrition or secondary malnutrition. Age and gender matched controls were selected from children admitted with diagnosis of pneumonia, acute gastro-enteritis, hepatitis, nephritis without any evidence of PEM.

After informed consent from the parents, detailed history and examination was performed. The anthropometric indices including weight were recorded in all patients and controls to assess the severity of PEM. The weight was recorded using the electronic weighing scale with precision of $\pm$ 5gm. Soon after admission 2 ml blood was collected in plain vacutainer for serum electrolytes estimation (sodium, potassium & calcium levels) and ECG was carried out in the controls and the cases using 12 lead Clarity electronic ECG machine (with small chest leads with recording speed of 25mm/sec) and results were analyzed by the principal investigator. In the ECG, heart rate, QRS axis, PR interval, QTc interval and ST segment changes were noted. All the collected data was filled in the predesigned proforma for the analysis

STATISTICAL ANALYSIS:

All the data was measured for central tendency using the mean and standard deviations and qualitative data using the frequency distribution. The quantitative variables with normal distribution were compared between the groups using ANOVA test and Chi square test was used for qualitative variables. For all statistical test P value <0.05 was considered significant.

RESULTS:

There were total 215 patients eligible for the study of which 65 patients refused to participate in the study and were excluded. Total of 150 patients were enrolled, of which 75 were cases and 75 were age and sex matched controls. The (Mean$\pm$ SD) age of cases was 2.1$\pm$1.1 years and that of controls was 2.04$\pm$ 1.1 years. There were total 92 males (61.3%) and 58 (42.7%) females in the study. The mean weight$\pm$ SD in cases was 7.3$\pm$3.0 kg and that in controls was 10.5$\pm$ 3.0 kg. (Table 1). There was statistically significant difference between the serum sodium, Potassium and calcium levels with that of controls (Table 2). The heart rate, PR interval, QTc interval were significantly different between the cases and controls. There was significantly higher percentage of ST segment changes in cases as compared to controls. (Table 2)

Table1: Baseline Demographic variables

variables	No PEM (Controls) N=75	PEM grade I N=17	PEM grade II N=28	PEM grade III N=21	PEM grade IV N=9
Age (years)	2.0$\pm$1.1	2.2$\pm$ 1.1	2.3$\pm$1.2	2.0$\pm$1.1	1.8$\pm$1.1
Male	40(53.3)	10(58.8)	18(64.3)	10(50)	4(44.4)
Female	35(46.7)	7(41.2)	10(35.7)	10(50)	5(45.6)
Weight (kg)	10.5$\pm$3.0	8.7$\pm$2.0	7.5$\pm$1.8	6.5$\pm$1.4	4.6$\pm$1.4

Values expressed as Mean $\pm$ SD / N (%)

Table 2: Comparison of electrolyte and ECG changes between cases and controls

Variables	No PEM (Controls) N=75	PEM grade I N=17	PEM grade II N=28	PEM grade III N=21	PEM grade IV N=9	F test statistics	P value

Serum Sodium Levels (meq/L)	136.6±6.0	131±7.3	128.7±4.6	125.7±7.3	123±7.2	22.49	<0.001
Serum Potassium Levels (meq/L)	4.2±0.8	3.7±0.7	3.6±1.0	3.7±0.9	2.9±0.6	7.78	<0.001
Serum Calcium Levels (mg/dL)	9.1±1.3	8.2±2.1	8.6±1.1	8.3±1.1	6.5±0.9	8.44	<0.001
Heart Rate	113.6±13.5	117.3±20.9	115.5±23.0	119.2±18.8	135±12.1	3.48	0.01
QRS axis degrees	72±29	80±20	79±22	85±41	73±40	1.01	0.407
PR interval (seconds)	0.08±0.02	0.07±0.03	0.08±0.03	0.08±0.03	0.11±0.04	3.42	0.01
QTc interval	0.28±0.06	0.33±0.07	0.38±0.07	0.37±0.08	0.43±0.08	20.02	<0.001
ST segment changes	1(1.3)	0(0)	1(3.6)	2(9.5)	3(33)		<0.001

Values expressed as Mean ± SD / N (%)

Bonferroni corrections for multiple group comparison was done to assess which group is different from another. On Bonferroni correction for multiple comparison group we found that, for controls , serum sodium levels were significantly different from all other cases (all PEM grade I to grade IV). Serum sodium levels in PEM grade I was significantly different from Controls and PEM grade IV. Serum potassium levels were significantly different between controls, PEM grade II and grade IV. Serum calcium levels were significantly different in PEM grade IV from controls and other grades of PEM. Heart rate was significantly different between PEM grade IV, PEM grade II and controls. There was no statistical difference with regard to QRS axis among the groups. PR interval was significantly different in all the groups from PEM grade IV. QTc interval was significantly different between controls and PEM grade II, III and grade IV. It was also different between grade I and Grade IV.

DISCUSSION:

Results of our study demonstrate that there were significant metabolic and electrocardiographic differences in patients with PEM as compared to controls. The Serum sodium levels, potassium levels and serum Calcium levels were significantly lower in patients with protein energy malnutrition as compared to controls which was also demonstrated by Said et al in their study.[4] Among the electrocardiographic changes, heart rate was significantly higher in severe form of malnutrition (PEM Grade II and PEM grade IV) as compared to controls. The PR interval and QTc was significantly longer in cases with severe PEM as compared to other grades of PEM or the controls.

The plausible reasons for this dyselectrolytemia could be due to decrease intake and increased losses from diarrhea which is a common morbidity in protein energy malnutrition. Though the total body sodium may increase in cases with malnutrition but hyponatremia is evident in view of increased Extra-cellular fluid compartment of body resulting in dilutional hyponatremia. The hypocalcemia can be explained because of decreased intake, decreased absorption and dysregulated parathyroid axis which controls the serum calcium. Decreased serum magnesium levels can also compound for decrease in the serum calcium levels. Taiwo et al aslo demonstrated improvement in the sodium and potassium levels on treatment of such patients. [5]

The Heart rate was significantly increased in patients with PEM grade II to IV which can be explained by increased total body water and congestive heart failure in these patients. The prolongation of PR and QTc interval can be due to systolic and diastolic dysfunction which may be exacerbated by coincident hypokalemia and hypocalcemia. Similar electrocardiographic findings were also reported by Gopalan et al and El Razaky et al. [6,7] The electrocardiographic changes are more common and more severe with higher grades of malnutrition like PEM grade IV. Kumar et al also demonstrated flattening of P waves, prolonged QTc interval with ST segment changes in malnourished children as was seen our study. These changes improved with treatment on follow up. [8]

To conclude, the associated electrolyte and ECG changes in patients with protein energy malnutrition needs to be picked up early and managed appropriately to decrease the morbidity and mortality in patients with severe malnutrition. The fluid therapy should be titrated as per the patient need as these patients usually presents with congestive heart failure. For same reasons oral feeds and ORS are preferred in such patients who can tolerate orally in comparison to the parenteral fluids.

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