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CLINICO-EPIDEMIOLOGY OF SEVERE MALNUTRITION AND ITS EFFECT ON HEART IN CHILDREN- A CASE CONTROL STUDY

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ABSTRACT **Introduction-** malnutrition has always been a major problem in India (affects around 80 lakh children under 5 years of age annually)1. There is a vicious cycle exist between infections and malnutrition. Unfortunately, pneumonia and diarrhea are the leading cause of Under-5-mortality in India2. We looked at the cardiovascular status in a malnourished child. **Methods-** A total of 100 children of age 6 months to 5 years were enrolled. Out of which 50 cases were the severely acute malnourished (SAM) as per the WHO growth standards and criteria, while 50 healthy children (age and sex matched) form the control group. Cardiac biomarkers and echocardiography had been done to evaluate and compare the cardiovascular status in malnourished children. **Results-** The mean Haemoglobin (mean± s.d.) of cases was 9.1380± 2.408 vs. the mean Haemoglobin (mean± s.d.) of controls was 9.2940± 2.124 (p=0.7320). The mean Serum Sodium mmol/l, serum calcium and serum potassium (mean± s.d.) of cases vs controls were 138.9 ± 6.408 vs. 139.5 ± 4.717(p=0.5951), 4.0540± .333 vs. 4.1712± .281 (p=0.0603) and 3.9552± .419 vs. 4.0378± .199 (p=0.2118) respectively. 19 (38.0%) cases were having elevated CKMB vs. 5 (10.0%) controls were having elevated CKMB(p=0.0010). 2 (4.0%) cases were having elevated TROP-I vs all controls [50 (100.0%)] were found to have normal TROP-I (p=0.1531). The mean LVEDD, LVESD, IVSD,LVPWD in centimetres (mean± s.d.) among cases and controls were 2.7080± .329 vs. 3.1300± .301(p<0.0001), 2.0080± .301 vs. 2.1660± .203 (p=0.0028), 0.4680± .101 vs. 0.5920± .0900 (p<0.0001) and 0.4200± .085 vs. 0.5880± .0627 (p<0.0001) respectively. The mean FS, EF, LVM and LVMI were also found to be significantly lower in malnourished children as compared to healthy controls (p<0.0001). **Conclusion-** A significant difference was found in structure and function of heart in a malnourished child as compared to a healthy child. These results could be useful during stabilization and rehabilitation of a malnourished child.

KEYWORDS : SAM (severe acute malnutrition), WHO (World Health Organization),

INTRODUCTION

Malnutrition refers to deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients[3]. The term malnutrition addresses 3 broad groups of condition: Undernutrition, Micronutrient related and overweight[3]. Severe acute malnutrition is a major public health issue. It affects an estimated 80 lakhs under-five children in India. In children between the ages of 6 and 59 months, Severe acute malnutrition (SAM) is defined as[4]:

i. Weight/height or Weight/length < -3 S.D. score, using the WHO Growth Charts; OR Presence of visible severe wasting; OR
ii. Presence of bipedal edema of nutritional origin; OR
iii. mid- upper arm circumference (MUAC) < 115 mm.

Earlier concepts stated that the heart is spared in malnutrition have been shown to be incorrect nowadays. Malnutrition (protein and energy) results in proportional loss of skeletal as well as myocardial muscle. As myocardial mass decreases in starvation, stroke volume and cardiac output fall proportionately. However, because of the decrease in body size the stroke-volume index and the cardiac index remain normal or rise slightly. In starvation there is a deficiency of protein substrate for maintenance of muscle protein. Metabolism is shifted toward catabolism of muscle protein for gluconeogenesis and maintenance of the body's other critical protein-requiring functions. The decrease in cardiac size is likely both a result of impaired myocardial protein maintenance and an adaptive response to decreased demands.[5]

Echocardiography has been the most widely used for the assessment of cardiovascular status in the body. Whether it is for screening, diagnosis, intervention, or follow up; echocardiography gives a wealth of information about structure and function of heart.[6] Therefore, we used this tool to look for any atrophic changes or pumping debility in the heart of a malnourished child.

METHODS

This was a prospective case control study carried out in department of Paediatrics, GSVM Medical College and LLR Hospital, Kanpur over the period of 20 months. After taking clearance from the institutional ethical committee, a written and informed consent was obtained from the parents. Total study population was 100, 50 each of cases and controls. The sample size was calculated by taking into account 90% confidence level and 8.2% margin of error among the 50,000-study population. Selection of cases and controls were done through random sampling method. Subjects fulfilling WHO criteria for Severe Acute Malnutrition were included, while the children with any known cardiac disease were excluded. Thereafter, routine blood investigation, cardiac biomarkers and echocardiography were done for all subjects. All the data were entered into a Microsoft excel spreadsheet and then analysed by SPSS (version 27.0; SPSS Inc., Chicago, IL, USA). Data was summarized as mean and standard deviation and test of significance were applied. Student t-test was applied to compare the two normally distributed data groups while group comparisons were made with the Chi-Square test or Fisher's exact test. A p value < 0.05 was considered significant. Analysis was conducted using IBM SPSS STATISTICS.

RESULTS

Overall, 100 children were enrolled (50 cases and 50 controls each) and compared in regards of basic demographic, chief complaints, routine blood parameters and echo finding.

It was found that distribution of subjects among cases and controls consist of almost similar proportions. Most of the children enrolled were <20 months age. Mean age of cases was 23 month and 27 months for controls.(Table-1)

Both cases and controls were also matched as per the gender.(Table-1)

Table-1: Basic Demographic Details

1-	AGE		CASES (n=50)	CONTROLS (n=50)	P-VALUE
		<20 MONTHS	24	20	
		20-40 MONTHS	21	19	
		41-60 MONTHS	5	11	
		TOTAL	50	50	0.56
2-	MEAN AGE (months)		23	27	0.09
3-	SEX				0.059
		MALE	28	26	
		FEMALE	22	24	

Most of the children had complaints of not gaining weight, decreased appetite and inadequate complementary feed initiation. (table-2). Recurrent cough, respiratory symptoms and diarrheal illness were also among the major complaint.

Table-2: Distribution Of Chief Complaints Of Subjects

CHIEF COMPLAINT		CASES (N=50)	CONTROLS (N=50)	
	NOT GAINING WEIGHT	33	15	0.0003
	DECREASED APPETITE	33	19	0.005
	INADEQUATE COMPLEMENTARY FEEDS	39	13	<0.0001
	RECURRENT RESPI INFECTION	22	12	0.034
	DIARRHEAL ILLNESS	10	6	0.27

Figure-1 Graphical Representation Of Major Chief Complains

The mean Haemoglobin (mean± s.d.) of cases and Control, was 9.1380± 2.4086. and 9.2940± 2.1240 respectively (p=0.7320).

The mean Sr Sodium mmol/l (mean± s.d.) of cases and controls was 138.9 ± 6.4087 and 139.5 ± 4.7175 respectively (p=0.5951). The mean Sr Calcium (mean± s.d.) of cases and control was 4.0540± .3333 and 4.1712± .2812 respectively (p=0.0603). The mean Sr potassium (mean± s.d.) of cases and control, was 3.9552± .4199. and 4.0378± .1990 respectively (p=0.2118).

This signifies that there was no significant difference seen in haemoglobin and serum electrolytes between cases and controls.

In table-3, we can see that 19 (38.0%) cases were having elevated CKMB while 5 (10.0%) controls were having elevated CKMB(p=0.0010). this showed a statistically significant association of elevated CKMB levels in malnourished child.

Two (4.0%) cases were having elevated TROP-I vs all controls [50 (100.0%)] were found to have normal TROP-I (p=0.1531). Association of raised Troponin-I with SAM children was statistically non-significant. (Table-3)

Table-3: Routine Blood Workup And Cardiac Biomarkers

			CASES	CONTROLS	P-VALUE
1-	MEAN HB (gm/dl)		9.13	9.29	0.372
2-	MEAN Sr. SODIUM (mmol/dl)		138.9	139.5	0.59
3-	MEAN Sr. CALCIUM (mmol/dl)		4.05	4.17	0.06
4-	MEAN Sr. POTASSIUM		3.95	4.03	0.211
5-	RAISED CK-MB		19	5	0.001
6-	ELEVATED TROPONIN-I		2	0	0.15

As per the table-4 The mean LVEDD, LVESD, IVSD,LVPWD in centimetres (mean± s.d.) among cases and controls were 2.7080± .329 vs. 3.1300± .301(p<0.0001), 2.0080± .301 vs. 2.1660± .203 (p=0.0028), 0.4680± .101 vs. 0.5920± .0900 (p<0.0001) and 0.4200± .085 vs. 0.5880± .0627 (p<0.0001) respectively.

This showed that all cardiac dimensions were significantly reduced in a SAM child as compared to a well-nourished child.

Table-4 Mean Cardiac Dimensions Measured By Echo-cardiography

	CARDIAC DIMENSIONS	CASES	CONTROLS	P-VALUE
1-	MEAN LVEDD cm	2.7	3.13	0.0001
2-	MEAN LVESD cm	2	2.16	0.0028
3-	MEAN IVSD cm	0.46	0.59	0.0001
4-	MEAN LVPWD cm	0.42	0.58	0.0001

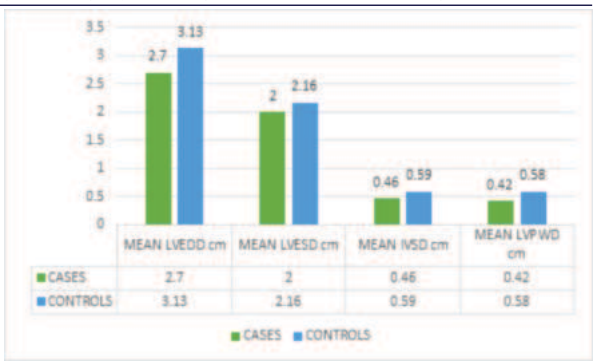

Figure-2 Graphical Distribution Of Cardiac Dimensions Among Study Population

When further parameters were derived using above dimensions like fractional shortening, ejection fraction, left ventricular mass and LV mass index, all of them were significantly found reduced in a SAM child. (Table-5) i.e., there is a significant reduction in hearts blood pumping capacity also.

Table-5 Mean Cardiac Parameters

		CASES (n=50)	CONTROLS (n=50)	P-VALUE
1-	MEAN FS	25.75	30.7	0.0002
2-	MEAN EF	57.61	66.48	0.0001
3-	MEAN LVM	23.43	42.3	0.0001
4-	MEAN LVMI	46.84	84.61	0.0001

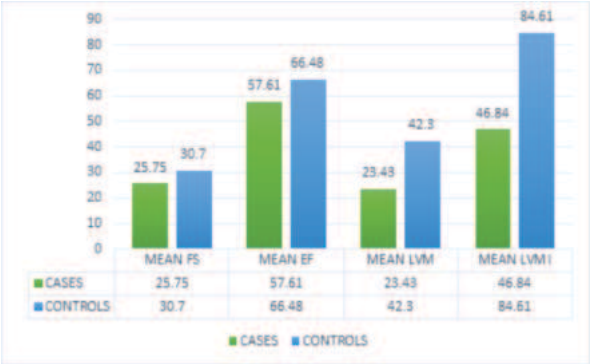

Figure-3 Graphical Distribution Of Cardiac Parameters Among Study Population

DISCUSSION

In our study, we had found that the mean haemoglobin among cases and controls were 9.13± 2.40 gm/dl and 9.29± 2.12 gm/dl respectively. This shows the prevalence of anaemia in the community among children aged 6 months to 5 years.

ELEVATED CKMB levels were significantly seen in malnourished children as compared to healthy, while troponin-I levels were not affected much.

Cardiac dimension were significantly reduced in malnourished children both during systole and diastole. All cardiac diameters LVEDD, LVESD, IVSD, LVPWD were markedly reduced among cases. Functional parameters like ejection fraction, fractional shortening and left ventricular mass were also markedly reduced in malnourished children.

Similar results were reported by Prashant Agarwal et al(2016)[7], where LVEDD,LVESD,LVPWD, LVM were significantly reduced and IVSD, EF, and FS were not much reduced in malnourished children. CKMB levels were significantly elevated among cases.

Ashutosh Sharma et al (2017)[8] also showed reduction in cardiac diameters both during systole and diastole. However, IVSD, FS and EF were not affected to that extent.

Senthil Raja Samikannu et al (2019)[9] had also reported marked reduction in LVEDD, LVESD, IVSD, LVPWD and LVM in malnourished children group.

Gihan. M. Bebars et al (2019)[10] also showed that malnourished children had a significantly lower anthropometric indices, haemoglobin, potassium and calcium levels in comparison to control group. In SAM children diastolic dysfunction grade II was detected in thirty percent (30%), while 40% have diastolic dysfunction grade I and 30% preserved normal diastolic function in comparison to 100% normal diastolic function in healthy group.

Mukesh Kumar Prajapati et al (2019)[11] found that all structural parameters viz the 'IVSs' during systole, IVSd during diastole, LVPWs during systole, LVPWd during diastole, and LVM, all parameters were significantly reduced in SAM children as compared to normal children and functional changes in the form of ejection fraction, fractional shortening and stroke volume were also significantly reduced.

Abu faddan et al(2010)[12] found interventricular septal diameter, posterior wall diameter, left ventricular mass to be reduced in malnourished patients in comparison to apparently healthy controls, fractional shortening and ejection fraction were also reduced, While end systolic diameter and end diastolic diameter were not significantly different among both groups.

CONCLUSION

Hence, we conclude that a protein energy malnutrition state itself causes significant myocardial atrophy and cardiovascular changes. This makes a malnourished child more prone to cardiac failure, arrhythmias and cardiomyopathy. With these finding, we emphasis better on stabilisation and rehabilitation of a sick malnourished with more judicious use of intra-venous fluids and blood product transfusion.

Abbreviation-

SAM (severe acute malnutrition), WHO (World Health Organization), LVEDD -Left ventricular end diastolic diameter, IVSD- Inter ventricular septal diameter, LVESD- Left ventricular end systolic diameter, LVPWD- Left ventricular posterior wall diameter, FS- Percentage of fractional shortening, EF- Ejection fraction, LVM- Left ventricular mass, CKMB- creatine kinase myocardial band

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Conflict Of Interest

There is no conflict of interest in this study.

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