Original Research Article

Study of myocardial function in children with severe acute malnutrition

Senthil Raja Samikannu[1], Senthil Kumar Palanivelu[2*]

[1]Department of Pediatrics, Institute of Child Health & Hospital for Children, Madras Medical College, Chennai, Tamil Nadu, India
[2]Department of Pediatrics, Government Medical College, Omandurar Government Estate, Chennai, Tamil Nadu, India
[*]Corresponding author email: **drsenthil_2700@yahoo.co.in**

International Archives of Integrated Medicine, Vol. 6, Issue 3, March, 2019.

Available online at http://iaimjournal.com/
ISSN: 2394-0026 (P) **ISSN: 2394-0034 (O)**
Received on: 23-02-2019 **Accepted on:** 27-02-2019
Source of support: Nil **Conflict of interest:** None declared.
How to cite this article: Senthil Raja Samikannu, Senthil Kumar Palanivelu. Study of myocardial function in children with severe acute malnutrition. IAIM, 2019; 6(3): 132-136.

Abstract

Background: Malnourished children suffer from many alterations in body composition, with loss of heart and skeletal muscle mass, complicated by electrolyte abnormalities and mineral or vitamin deficiencies that could produce cardiac abnormalities, including hypotension, cardiac arrhythmias and cardiomyopathy, cardiac failure and even sudden death.
The aim of the study: The present study was undertaken to study the myocardial function and cardiac chamber dimensions in children with severe acute malnutrition admitted in a tertiary care center. **Materials and methods:** This case-control study included WHO criteria for Severe Acute Malnutrition (SAM) satisfying children as cases and healthy children as controls. Anthropometric data were collected and echocardiographic evaluation is done for all children.
Results: Left ventricular end systolic diameter, diastolic diameter, inter ventricular septum thickness, posterior wall thickness, left ventricular mass and mass index were significantly lower in malnourished children compared to the healthy control group.
Conclusion: In the present study, left ventricular dimensions were found to be reduced in malnourished children; hence, assessment of these parameters may prove to be an important tool in early detection of cardiac dysfunction in severe acute malnutrition, which may help in reducing morbidity and mortality related to severe acute malnutrition.

Key words

Severe Acute Malnutrition, Left Ventricle Mass, Ejection Fraction.

Introduction

Malnutrition is a major public health and developmental issue in India as well as other parts of the world especially in developing countries in children under five years of age. According to WHO, nearly 20 million children are affected by severe acute malnutrition (SAM) globally, among them, most of the children live in Africa and South Asia [1]. About 1 million children die due to SAM every year. The mortality rate is 5-20 times more than well-nourished children. According to National Family Health Survey -3 (NFHS-3) among under 5 age group, 43%are underweight (low weight for age), 48% children are stunted (low height for age), 20% children are wasted (low weight for height) [2]. Among these wasted children, more than 6 % are severely wasted (<-3SD) called as Severe Acute Malnutrition. There is a strong correlation between malnutrition and childhood mortality due to common illness like respiratory tract infection, diarrhea, measles, and malaria [3]. WHO diagnostic criteria of children aged 6-60 months for SAM was as per **Table – 1**.

Table - 1: WHO diagnostic criteria of children aged 6-60 months for SAM [2, 3]

Measure	Cut off	Indicator
Weight for height	<3 SD	Severe wasting
MUAC	<115 mm	Severe wasting
Clinical sign	-	Bilateral edema

Metabolic response to inadequate energy intake: In the absence of infection, starvation leads to fat stores being depleted initially followed by glycogen stores. These changes are mediated by endocrine and metabolic alteration that results in preserving vital function. The vital organs like liver and other viscera are relatively preserved. The total body water content is increased which is mostly extracellular fluid. Sodium retention will occur which will increase whole body sodium leading to increased extracellular fluid even when serum sodium is low. The total serum potassium is decreased even when serum potassium remains normal [4].

Changes in cardiovascular system: Cardiac output is reduced in acute protein-energy malnutrition when compared with the recovery phase. Myocardial contractility is normal with non-specific changes. Mild hypotension and sinus bradycardia may be present. Pericardial effusion is present in edematous children. Associated deficiencies like anemia, hypokalemia, vitamin deficiencies affect the cardiac function. During the recovery phase, the heart size is increased due to enlargement of the heart chambers. The left ventricle mass also increases proportionately to weight during the recovery period. During rapid diet repletion, sodium overload occurs leading to heart failure and sudden death. Animal studies have hence proved that malnutrition has a direct effect on the cardiovascular system. Alden et al did a study in dogs where a total of 21 dogs were studied [5]. Among them regular diet was given to ten dogs and protein-calorie deficit diet was given to eleven dogs to achieve mean weight loss of 20-25% over a three week period. Echocardiographic evaluation was done in both the groups at one week and at 3 weeks. In the malnourished dogs, cardiac muscle was reduced in proportion to total body mass loss. The mean cardiac mass decreased from 115 to 91. This is mainly due to the thinning of the left ventricle wall. Heart rate reduced from 125 to 79 beats per min. Ejection fraction increased from 29.8 to 34.6%, cardiac output decreased from 2.98 to 2.38 liter per min with malnutrition. There was no significant change in the hemodynamic status of the control group [6]. Acute PEM causes significant cardiac atrophy, reflected as reduced cardiac output and decreased contractility with no change in the intrinsic property of the myocardium. Malnourished children had significantly decreased left ventricular wall thickness in the posterior wall and septum, decreased ejection fraction with reduced cardiac output and contractility. Children with malnutrition are frequently associated with vitamins and micronutrient deficiencies. Among these most important are deficiencies of thiamine and selenium which cause beriberi and cardiomyopathy (Keshan disease) [7].

Materials and methods

This case-control study was done at the Institute of Child Health and hospital for children, Madras Medical College, Egmore, Chennai between April 2014 to November 2014. Forty-one children with severe acute malnutrition, according to WHO criteria were included in this study. Twenty-one children were kept as controls. Preterm, Intrauterine growth retardation (IUGR) at birth infants, those with congenital and acquired heart disease and severe anemia (<7 gm/dl) were excluded. Children were included in this study after obtaining informed consent from parent or guardian. Weight, Height and mid-upper arm circumference (MUAC) were recorded. Echocardiographic evaluation of cardiac dimensions, wall thickness, and estimation of indices of Left ventricle systolic and diastolic function was done for the children. The children were weighed using an electronic weighing scale and in children below 2 years length were measured using infantometer and above 2 years height was measured using stadiometer. Weight and length/height were plotted on the WHO growth chart. As per the chart weight for length or height Z score less than -3 standard deviations were classified as SAM and included in the study. MUAC was measured in children with age 1-5 years. Children with less than 11.5cm were classified as SAM in this study as cases. Children with weight for length /height Z score between -1 to +3 standard deviation were considered as normal and included as controls in this study. Echocardiographic evaluation was done in all children included in the study to access chamber dimensions, ventricular function, pericardial effusion, left ventricular mass (LVM), left ventricular mass index (LVMI) is calculated by LVMI calculator with left ventricle end diastolic diameter (LVEDD), Posterior wall diameter (PWD), Inter ventricular septal diameter (IVSD) parameters indexed to body surface area (g/m^2). Left ventricular systolic function evaluated by ejection fraction (EF), Fractional shortening (FS), and systolic time interval. Fractional shortening is a reliable and reproducible index of left ventricular function which was calculated by the formula – FS(%) = LVEDD-LVESD/LVEDDx100. Normal FS =36% (28-44). Ejection fraction was derived from the fractional shortening and was calculated by the - EF(%) = $LVEDD^2$-$LVESD^2$/$LVEDD^2$ x100.Normal EF = 66%.

Statistical analysis: All data were collected in data collection form, then entered in excel spreadsheet. For statistical analysis, SPSS version 16 was used. The standard deviation and mean were calculated for continuous data. Independent-t-test was used to compare the echo variables.

Results

Totally 62 children were included in the study, malnutrition based fulling children were 41 and 21 severed as controls. Age group was between 12-48 months (**Graph – 1**).

Graph – 1: Age distribution.

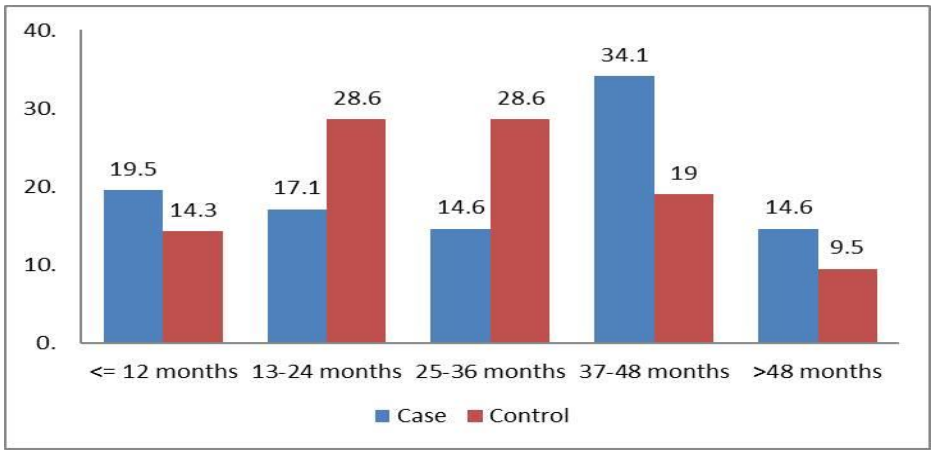

Table - 2: Anthropometry in the cases and controls.

	Group	N	Mean	Standard Deviation	P value
Weight (kg)	Control	21	13.952	3.073	<0.001
	Case	41	7.57	1.490	
Height (cm)	Control	21	90.857	11.087	<0.001
	Case	41	79.341	8.493	
MUAC (cm) (Mid upper arm circumference)	Control	19	13.900	0.4643	<0.001
	Case	39	10.928	0.4205	

Table – 3: Mean of LVEDD, LVESD, PWT and IVSD between cases and controls.

	Group	N	Mean	Standard Deviation	P value
LVEDD(cm)	Control	21	3.6057	0.3009	<0.001
	Case	41	2.8388	0.4314	
LVESD(cm)	Control	21	2.3933	0.18866	<0.001
	Case	41	1.8978	0.34157	
PWT(cm)	Control	21	0.4857	0.06918	<0.001
	Case	41	0.3276	0.04999	
IVSD(cm)	Control	21	0.4929	0.06619	<0.001
	Case	41	0.3737	0.07081	
EF (%)	Control	21	65.895	1.4313	0.404
	Case	41	65.024	4.6149	
FS (%)	Control	21	33.548	1.1609	0.809
	Case	41	33.354	3.547	
LVM (gm)	Control	21	43.048	12.9749	<0.001
	Case	41	19.341	7.8823	
LVMI (g/m^2)	Control	21	71.133	10.6336	<0.001
	Case	41	46.756	15.3847	

Table - 2 shows majority of children in both cases and control group were in the 1-4years age group. There was a significant difference in the mean weight, height and mid-upper arm circumference between cases and controls ($p<0.001$).

Echocardiographic evaluation of the cases revealed a significant decrease in the LV End Diastolic Diameter, Systolic Diameter, Posterior Wall Thickness, and Inter-Ventricular Septal diameter compared to the control group. A left ventricular mass and mass index was lower in the cases. There was no significant difference in the ejection fraction and fractional shortening between the cases and controls (**Table – 3**).

Discussion

SAM is a serious disease responsible for increased mortality and morbidity in children under 5 years in developing countries. Echocardiographic study of children with SAM in the present study showed left ventricular end diastolic diameter, end systolic diameter, a posterior wall, and interventricular septal thickness were significantly decreased than healthy control group children [8]. The left ventricular mass and left ventricular mass index also was significantly low in malnourished children compared to the control group [9]. Our study findings were similar to study done by Olivares JL, et al. who described reduced left ventricular mass and mass index in malnourished children [10]. Phornphatkul C, et al. also noted findings similar to our study. In his study cardiac evaluation was done in 30 protein-energy malnourished children including both edematous

and non-edematous children before and after nutritional rehabilitation. LV mass index which was reduced in malnourished children includes following nutritional rehabilitation left ventricle systolic function parameters (fractional shortening and ejection fraction) were not significantly different in malnourished children than healthy controls [11]. Singh GR described left ventricular dysfunction in moderate to severe protein-energy malnutrition [12].

Conclusion

In Severe Acute Malnutrition, though ejection fraction remains relatively normal the LV mass, mass index and LV chamber dimensions are significantly decreased compared to the control group. Hence, it is necessary to intervene severely malnourished children early so that further worsening of cardiac function is prevented.

Acknowledgments

The authors would like to thank the Professors, Associate Professor, and Postgraduate students, Department of Pediatrics, Madras Medical College, Egmore, Chennai for helping with data collection and analyses.

References

1. Alden PB, Madoff RD, Stahl TJ, Lakatua DJ, Ring WS, Cerra FB. Left ventricular function in malnutrition. Am J Physiology, 1987 Aug; 253(2 Pt 2): H380-7.
2. Ammann P, Fehr T, Minder El, Gunter C, Bertel O. Elevation of troponin I in sepsis and septic shock. Intensive care med., 2001 Jun; 27(6): 965-9.
3. Checchia PA, Appel HJ, Kahn S, Smith FA, Shulman ST, Pahl E, Baden HP. Myocardial injury in children with respiratory syncytial virus infection. Pediatr crit care med., 2000 Oct; 1(2): 146-50.
4. Elst KM, Spapen HD, Nguyen DN, Garber C, Huyghens LP, Gorus FK. Cardiac troponins I and T are biological markers of left ventricular dysfunction in septic shock. Clin Chem., 2000 May; 46(5): 650-7.
5. Gunnewiek JM, Van Der Hoeven JG. Cardiac troponin elevations among critically ill patients. Curr Opin Crit Care, 2004 Oct; 10(5): 342-6.
6. Khan IA, Tun A, Wattanasauwan N, Win MT, Hla TA, Hussain, Vasavada BC, Sacchi TJ. Elevation of serum cardiac troponin I in noncardiac and cardiac diseases other than acute coronary syndromes. Am J Emerg Med., 1999 May; 17(3): 225-9.
7. Kothari SS, Patel TM, Shetland AN, Patel TK. Left ventricular mass and function in children with severe protein-energy malnutrition. Int J Cardiol., 1992 Apr; 35(1): 19-25.
8. Maggiorini M, Ammann P, Bertel O, Haenseler E, Joller-Jemelka HI, Oechslin E, Minder EI, Rickli H, Fehr T. Troponin as a risk factor for mortality in critically ill patients without acute coronary syndromes. J Am Coll Cardiol., 2003 Jun 4; 41(11): 2004-9.
9. Ocala B, Unal S, Zoru P, Tezic HT, Oquz D. Echocardiographic evaluation of cardiac functions and left ventricular mass in children with malnutrition. J Paediatric Child Health, 2001 Feb; 37(1): 14-7 13.
10. Olivares JL, Vazquez M, Rodriquez G, Samper P, Fleata J. Electrocardiographic and Echocardiographic findings in malnourished children. J Am Coll Nutr., 2005 Feb; 24(1): 38-43.
11. Phornphatkul C, Pongprot Y, George V, Fuchs G. Cardiac function in malnourished children. Clin Pediatr (Phila)., 1994 Mar; 33(3): 147-54.
12. Singh GR, Malathi KE, Kasliwal RR, Ommar A, Padmavathi S, Ramji S. An evaluation of cardiac function in malnourished children by non-invasive methods. Indian Pediatr., 1989 Sep; 26(29): 875-81.