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Research Article

Myocardial performance index in severe acute malnutrition children aged 6 month to 5 years

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ABSTRACT

Background: Severe Acute Malnutrition (SAM) is one of the most common health problems. Children suffering from SAM frequently exhibit cardiovascular abnormalities leading to morbidity and mortality. We evaluated myocardial performance index (MPI) to measure both systolic and diastolic functions of the heart.
Methods: Hospital based prospective study in which we enrolled 100 children with SAM aged 6 months to 5 years admitted in malnutrition treatment centre (MTC), Bal Chikitaslya, Udaipur, Rajasthan, India. All the children underwent a detailed clinical and echocardiographic evaluation. The different echocardiographic variables along with MPI were calculated.
Results: Out of 100 children majority of study population was in <-3SD, Z-score and <-4 SD, Z-score (63%), although extremes like <-5 SD to <-7SD, Z-score were also noted in 35% of children. In echocardigraphic variables ventricular function as mean ejection fraction was normal (70.69±9.57). The mean MPI was 0.41±0.11 with p-value of <0.001.
Conclusions: MPI in SAM children was abnormally high inspite of normal ejection fraction. This can be used in children with SAM as early marker of ventricular dysfunction even before ejection fraction starts declining.

Keywords: Echocardiography, Myocardial performance index, Severe acute malnutrition, WHO SD Z-score

INTRODUCTION

Severe acute malnutrition (SAM) is one of the most common health problem, involving hundreds of millions of children in the world.[1]According to National Family Health Survey–III, in India 6.4% of children below 60 months of age suffer from SAM, which constitutes around 8 million. With the current estimated population of India as 1100 million, it is expected that about 8.1 million are likely to be suffering from SAM.[2]

Children suffering from severe malnutrition frequently exhibit cardiovascular abnormalities including hypotension, cardiac arrhythmias, cardiomyopathy, cardiac failure and in some cases death. It remain unresolved, however, if these abnormalities are primary phenomenon of malnutrition or secondary to other abnormalities commonly associated with severe malnutrition, such as sepsis.[3-5]

The heart atrophies during starvation, but controversy persist as to whether the atrophic heart with PEM functions normally or demonstrates left ventricular dysfunction.[3,6-9] Also, it was not clear whether there is a difference in cardiac performance as a function of type and severity of protein energy malnutrition (PEM).

We evaluated myocardial performance index (MPI) which is a novel index that incorporates measures of both systolic and diastolic performance of heart and this index

is a more sensitive early measure of ventricular performance before any isolated abnormalities of systolic or diastolic parameters appear. Higher the value worse the performance.[10]

METHODS

In this hospital based prospective study from Jan 2014 to Dec. 2014, we included 100 children with severe acute malnutrition aged 6 month to 5 years admitted in malnutrition treatment centre (MTC), Bal Chikitsalaya, Udaipur, India. The study was approved by the ethical committee of the institute.

A written informed consent was taken from parents of all malnourished children who fulfilled the inclusion criteria as per WHO reference of SAM in children of 6 months to 5 years.

- Weight for height/length <- 3SD.
- Mid upper arm circumference (MUAC) of <11.5 cm.
- Bipedal nutritional edema.

Exclusion criteria

- Children who were born either premature or post mature and/or were small for gestational age or large for gestational age.
- Any documented cardiothoracic event (congenital heart disease, pericarditis, cardiomyopathy, acute severe lower respiratory tract infection).
- Severe anemia (haemoglobin level < 6 gm/dl).

All the enrolled children underwent a detailed clinical examination, including anthropometry (weight, length/height, mid upper arm circumference, body mass index (BMI) and body surface area (BSA) and echocardiography, which was performed with GE vivid 7 machines with 4 mHz transducer. Echocardiography was done after giving an oral medication of hypnotic drug (chloral hydrate) in a dose of 50 mg/kg. The echocardiographic recording was taken when patient was in supine position without breath holding.

MPI (Tei index) was calculated by

$$\text{MPI} = \frac{\text{Total systolic time (TST)} - \text{Ejection time (ET)}}{Ejection\ time\ (ET)}$$

This can also be written as,

$$\text{MPI} = \frac{IVCT + IVRT}{ET}$$

IVCT – Isovolumetric contraction time

IVRT- Isovolumetric relaxation time

In children less than 5 years the normal value of MPI was taken as 0.36.[11]

Statistical analysis

Results are expressed as mean ± standard deviation for continuous variables and as number (%) for categorical data. Since all data were normally distributed, the parametric tests were used for statistical analysis. Differences between echocardiographic variables of malnourished children and the normal children with same age were determined by Student's t-test (independent group t-test). Pearson's correlation analysis was used to determine correlations between different variables. Multiple groups were compared using the ANOVA test. For all tests, the difference was considered significant if the probability (P) was <0.05.

RESULTS

A total of 100 children who fulfilled the criteria of SAM were taken into study, out of which 61 were males and 39 were females. Mean age of study population was 19.01±11.08 months. Majority of population (84%) of study children were in the age group of 6 months to 2 years (Table 1).

Table 1: Age-wise distribution of study group.

Age(months)	No. of children		Percentage
	Male	Female	Total
6-≤12	27	18	45%
12-≤24	26	13	39%
24-≤60	8	8	16%
Mean ± SD	18.59 ±10.83	19.6±11.57	19.01 ± 11.08

Majority of our study population was in <-3 SD, Z-score and <-4 SD, Z-score (63.0%) although extremes like <-5, <-6, <-7 SD, Z-score were also noted in 35.0% of population, based on SD Z-score as per WHO as shown in Table 2.

Table 2: Distribution of study group according to WFH/L (WHO SD Z-score).

SD Z score	No. of children	Percentage
<-2 SD z- score	2	2.0%
<-3 SD z- score	28	28.0%
<-4 SD z- score	35	35.0%
<-5 SD z- score	21	21.0%
<-6 SD z- score	8	8.0%
<-7 SD z- score	6	6.0%
Total	100	100.0%

As per various criteria's of SAM, 98.0% of children were SAM as per weight for length/height criteria, while 73.0% of children fulfilled MUAC criteria whereas only 6.0% fulfilled criteria of nutritional edema. The mean of

different variables of SAM patients were as shown in Table 3.

The basic mean Echocardiographic variables were as shown in Table 4. The Ejection fraction (Ef) was normal as 70.69±9.57.

As shown in Table 5, the mean MPI of the study population was 0.41±0.11 with p=0.001, when this was compared with MPI of normal healthy children value (0.36) it shows statistically significance with p-value <0.001. MPI among various SD, Z-score was not significant.

Table 3: Basic Anthropometric variables in SAM patients.

Variable	Mean	Standard deviation
Age (months)	19.01	11.08
Weight (kg)	6.41	1.64
Height/length (cm)	73.40	8.24
MUAC(cm)	10.91	1.28
BMI	11.76	1.43
BSA	0.35	0.06

Table 4: Echocardiographic variables in study SAM children.

Parameters	Mean	SD
IVSd	0.484	0.08
IVSs	0.730	0.17
LVIDd	2.05	0.35
LVIDs	1.24	0.28
LVPWd	0.46	0.09
LVPWs	0.775	0.14
ESV	4.28	2.30
EDV	14.62	5.96
SV	9.96	4.10
EF	70.69	9.57
FS	38.50	7.92
ET	182.99	26.61
TST	255.81	36.59
MPI	0.41	0.001 *

IVSd- Inter ventricular septal dimension in diastole, IVSS-Inter ventrivular septal dimension in systole, LVIDd- Left ventricular internal dimension in diastole, LVIDs- Left ventricular internal dimension in systole, LVPWd - Left ventricular posterior wall dimension in diastole, LVPWs- Left ventricular posterior wall dimension in systole, EDV- End diastolic volume, ESV- End systolic volume, SV- Stroke voume, EF- Ejection fraction, FS- Fractional shortening, ET- Ejection time, TST – Total systolic yime, MPI- Myocardial performance index.

Table 5: Deviation of MPI in different categories of WHO SD z score*.

MPI	N	Mean	SD	p value
<-2 SD	2	0.48	0.07	0.257
<-3 SD	28	0.40	0.12	0.058
<-4 SD	35	0.40	0.11	0.023
<-5 SD	21	0.39	0.10	0.113
<-6 SD	8	0.48	0.19	0.104
<-7 SD	6	0.42	0.07	0.091
TOTAL	100	0.41	0.11	0.001*

*Normal value 0.36

DISCUSSION

In this hospital based prospective and correlation study, we found that MPI was higher than the value in normal children and this was also statistically highly significant (p-value<0.001) in spite of normal ejection fraction. There have been no study in malnourished children which has taken MPI into consideration and since MPI has been shown to be sensitive predictor of outcome in children as well in adults.[10]

The index is simple, non-invasive, easy to estimate and reproducible.[11] A number of studies have documented that the MPI (Tei index) is independent of arterial pressure, heart rate, ventricular geometry, atrioventricular valve regurgitation, afterload and preload in patients who are in a supine position.[12-15]

The limitation of our study is lack of case control which would have given the better understanding of normal values of MPI in children of this area also.

To conclude SAM affects cardiac functions as evident by high MPI which can be determined by easy, non-invasive echocardiography very early before decline of ejection fraction. Future studies are recommended for MPI in normal as well as in SAM children for assessing ventricular dysfunction till that our data's may be used as a base line.

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