COMPARATIVE ECHOCARDIOGRAPHIC ANALYSIS OF CARDIAC FUNCTION AND LEFT VENTRICULAR MASS AMONG CHILDREN ADMITTED WITH SEVERE ACUTE MALNUTRITION IN JIMMA UNIVERSITY SPECIALIZED HOSPITAL, 2013.

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A RESEARCH PAPER TO BE SUBMITTED TO JIMMA UNIVERSITY COLLEGE OF PUBLIC HEALTH AND MEDICAL SCIENCES, SCHOOL OF GRADUATE STUDIES, DEPARTMENT OF PEDIATRICS AND CHILD HEALTH AS PARTIAL FULFILLMENT FOR THE REQUIREMENT OF SPECIALITY CERTIFICATE IN PEDIATRICS AND CHILD HEALTH

JULY, 2013

JIMMA, ETHIOPIA

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Abstract

Introduction: *Malnutrition is one of the leading problems in developing countries with basic stance for majority of common childhood problems. The clinical forms that are prominent and are associated with mortality are the severe forms of acute malnutrition (edematous or non-edematous). Malnutrition affects every organ system. One of the most important organs involved- cardiac muscle was studied in this paper. The objective of this study was to compare the degree of cardiac muscle involvement among severely malnourished children in contrast with age and sex matched anthropometrically normal controls. It will be used as a baseline data for further detailed study in addition to its impact in the management of children with severe acute malnutrition by detailing cardiac function.*

Methods and patients: *The study was a cross sectional comparative case control study among thirty children with severe acute malnutrition and age-sex matched fifteen control groups in JUSH pediatrics department from January to July 2013. Convenient selection of cases and controls with clearing of exclusion criteria was used after written consent was taken to select the legible 30 children who were not having any of the exclusion criteria seated. Fifteen children were selected as controls with anthropometric measures between ±2SD. Each child had undergone basic clinical examination (general examination, cardiorespiratory, integumentary and anthropometric measurement and interpretation) and echocardiographic assessment of LV mass, dimensions and systolic functions. Blood sample was taken for baseline investigation on hemoglobin/hematocrit. Results were expressed as means ± standard error of means and considered statistically significant if $p < 0.05$. Student t-test was used for comparison of means and standards using web based software "GraphPad calcs". SPSS®, EpiData, WHO Anthro were used in accordance.*

Results: *The mean ages for the cases were 2.4±1.7 years and for the control group was 3.3±1.8 years with males took 53.3% comparably in both groups. It was found that Left ventricular posterior free wall thickness and LV mass were reduced significantly in the group with SAM (P = 0.0001) whereas LVMi and systolic functions (Ejection Fraction and Fractional Shortening) were not found to be statistically significant. The lowest mean value for EF and FS was on the edematous SAM children.*

Conclusion and Recommendation: *This study has revealed that there was cardiac atrophy without significant systolic functional impairment. I recommend that we need to have a more detailed study with biochemical markers being integrated and severely malnourished children being followed prospectively for the changes with due treatment.*

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This paper comes to action and gets finalized with all the support from the department of Pediatrics and child health, Jimma University with its philosophy of community based program. At this very juncture I would like to thank all guardians who were so cooperative to take part in the research and professional colleagues who were supportive from start till finalizing this paper.

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Acronyms

BSA	Body Surface Area
HFA	Height for Age
IT	Information Technology
JUSH	Jimma University Specialized Hospital
LV	Left Ventricle
LVEd	Left ventricular dimension in end-diastole
LVEs	left ventricular dimension in end-systole
LVm	left ventricular mass
Lvmi	left ventricular mass index
MD	Medical Doctor
MUAC	Midupper arm circumference
NCHS	National Centre for Health Statistics
PEM	Protein –Energy Malnutrition
SPSS	Software Program for Social studies
WFA	Weight for Age
WFH	Weight for Height
WHO	World Health Organization

Chapter one

1. Introduction

Malnutrition is one of the leading problems in developing countries with basic stance for majority of common childhood problems. Of the nearly 1.9 billion children in the developing world, 31% are stunted (1, 2). Despite the continued progress in all the developing countries, it is still predicted that there will be 128-155 million underweight children by the year 2020 with 35% of these children to be from sub-Saharan Africa (3). With regard to the Ethiopian condition, 44% of children under-five year of age were stunted, 29% and 10% of children were underweight and wasted respectively according to the Ethiopian Demographic Health Survey published in 2011 (4).

Malnutrition is the condition that occurs when a person's body is not getting enough nutrients. The condition may result from an inadequate or unbalanced diet, digestive difficulties, absorption problems, or other medical conditions (1). Marasmus is a form of severe acute malnutrition characterized by energy deficiency (5). Marasmus is one of the three forms of Severe Acute Malnutrition (SAM). The other 2 are kwashiorkor and marasmic kwashiorkor. These forms of SAM represent a group of pathologic conditions associated with a nutritional and energy deficit occurring mainly in young children from developing countries at the time of weaning. Marasmus occurrence increases prior to age 1, whereas kwashiorkor occurrence increases after 18 months. The prognosis is better than it is in kwashiorkor (6).

Kwashiorkor is a type of malnutrition with obscure causes; it was believed to be caused by insufficient protein consumption and/or excessive oxidative stress. This is now being challenged with different studies as described by Michelle I. Smith et al, 2013 by detailing the cause being linked with the gut microbiome (7). It usually affects children aged 1–4 years, although it also occurs in older children and adults (6). Symptoms of kwashiorkor include a swollen abdomen known as a pot belly, as well as alternating bands of pale and dark hair (flag sign) and weight loss. Common skin symptoms include dermatitis and depigmented skin (6). Marasmic kwashiorkor is a condition in which there is severe tissue wasting, loss of subcutaneous fat, and usually dehydration. It is the most severe form of protein-energy malnutrition in children, with weight for height less than 60% of that expected, and with edema and other symptoms of kwashiorkor (5). Undernutrtion is usually thought of as a deficiency primarily of calories (that is, overall food consumption) or of protein. Deficiencies of vitamins and minerals are usually considered separate disorders. (6)

In 2007, Lin et al stated that "a prospective assessment of food and nutrient intake in a population of Malawian children at risk for kwashiorkor" found "no association between the development of kwashiorkor and the consumption of any food or nutrient" (8). Marasmus and kwashiorkor can both be associated with impaired glucose clearance that relates to dysfunction of pancreatic beta-cells (9). In-utero, plastic mechanisms appear to operate, adjusting metabolic physiology and adapting postnatal undernutrition and malnutrition to define whether marasmus and kwashiorkor will develop (10).

Concepts of the effect of starvation on the heart have recently changed. The earliest report of a study by Voit in 1866, involved two cats; one of which was starved for 13 days. Comparing the hearts of the two, Voit found that the heart of the starved cat was only slightly smaller, and he concluded that the heart is "spared" in malnutrition (11). This concept was widely accepted until it became evident from large autopsy studies of starved people that the amount of cardiac tissue is usually reduced in proportion to the degree of emaciation of the rest of the body (12).

A well-functioning heart, among other characteristics, beats slowly and ejects a large volume with each stroke. In addition, as the ventricle stretches the wall thickness is reduced. Hence, the stroke volume and muscle wall thickness in relation to ventricular diameter has been used to determine the effect of protein-energy nutrition on cardiac function. Studies have been done in individuals with weight loss (13), and normal and obese subjects (14). When these data are compiled it is clear that with weight loss the stroke volume falls and the ventricular wall becomes thinner and vice versa. In addition, malnutrition is associated with reduced oxygen consumption and a corresponding fall in cardiac output.

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 (15-17). In addition, systolic ejection phase indices of left ventricular function, such as ejection fraction and mean rate of shortening of left ventricular circumferential fibers, remain normal or increase slightly (16). Therefore, despite the decrease in muscle mass, the needs of the circulation are met by these compensatory mechanisms.

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 as a result of impaired myocardial protein maintenance and an adaptive response to decreased demands.

The effect of Severe Acute malnutrition on the heart may not be well recognized because it so rarely results in cardiac failure. Various compensatory mechanisms mask the effects of myocardial atrophy. Notably, blood pressure, heart rate, blood volume and metabolic demands for oxygen delivery decrease in the malnourished patient (16, 18-21). There are situations where we should consider the significant heart muscle impairment. The patient with chronic cardiac failure and cardiac cachexia; the patient exposed to increased metabolic demands such as those that may occur with surgery or parenteral nutrition; and the genesis of arrhythmias are the major issues to be raised in the development of clinically significant heart failure with the background of protein energy malnutrition (22).

In this research the effect of malnutrition on cardiac function was described by taking the Left ventricular mass and mass index with measurements of ejection fraction, fractional shortening and left ventricular dimensions. It has compared severely malnourished children with normal children to demonstrate variations in the systolic cardiac functional status, LV mass and mass index.

Chapter Two

2. Objectives

2.1 General objective

This research was planned to compare cardiac function between children with severe acute malnutrition admitted in the ward and normal children from outpatient department during the study period in JUSH, 2013.

2.2 Specific objectives

- To measure left ventricular mass and mass index using echocardiography among the study population JUSH, 2013
- To determine left ventricular function (left ventricular dimension and fractional shortening) and compare among the study population JUSH, 2013

Chapter Three

3. Patients and methods

3.1 Study setting

The research project was undertaken at Jimma University Specialized Hospital, Pediatrics Nutritional Rehabilitation Unit (NRU) and OPD, Jimma, Ethiopia. Pediatrics ward has NRU as a separate ward which itself is designed in a way that patients get their treatment in a phased approach, phases 1, 2 and transition. Each phase has its own management approach based on the protocol (protocol for the management of severe acute malnutrition, Ethiopia-Federal ministry of health, March 2007).

3.2 Study design

It was a hospital based case-control study that included severely malnourished children (WFH or WFL < 70% of median based on NCHS reference **or** MUAC < 110 mm with a Length > 65 cm **or** bilateral pitting edema) (0.5-8 years of age) as a case and age and sex matched healthy and anthropometrically normal (both WFH or WFL and HFA or LFA ±2**Z** score according to WHO growth standard) children from the out-patient department.

3.3 Study population

The study population was comprised of children at admission to the pediatric nutritional rehabilitation unit (over 24-48 hours after admission) and children coming to outpatient department for any other complaint (who had fulfilled the nutritional assessment and other inclusion criteria) after consent is taken from the guardian and exclusion criteria were cleared.

All patients aged 6-84 months with severe acute malnutrition admitted to pediatrics ward (to cover majority of cases with severe acute malnutrition by age) and age matched “healthy children” were used as control groups with little available resource and quiet limited study period. A total of 30 children were studied as cases and 15 as controls. Sample size determination was confounded by the absence of basic data from the local study and also other studies have not revealed conclusive clue for appropriate use of function impairment as the least available plausible approach. With all of which sample size rests extremes.

The evidence of available literatures reviewed with comparable problems to settle the sample size were mentioned above. Two groups were labeled as those with a diagnosis of severe acute malnutrition (comparable number of edematous and non edematous groups) and those children who were healthy coming for other complaint to the outpatient department, 15 children. Cautious exclusion of children based on the exclusion criteria was made by pediatric resident.

3.3.1 Exclusion criteria

- Preterm or a child with intrauterine growth retardation (for both cases and controls after positive or suspicious history is identified)
- A child with documented cardiac illness or murmur identified on clinical examination or significant structural cardiac lesion from echocardiography(for both cases and controls)
- A child with signs of cardio-respiratory distress (chest indrawing, orthopnea, tachycardia, cyanosis peripheral or central), for both cases and controls
- A child with severe anemia at presentation (hemoglobin < 5mg/dl or having severe palmar pallor from clinical examination) for both cases and controls
- A child with malnutrition in treatment for more than 48 hours
- For controls who fail to lie in between -2SD and 2SD of the WHO simplified field table of multicentre growth reference study with their WFL or WFH and LFA or HFA during anthropometric assessment

3.3.2 Inclusion criteria

- Age 6-84 months
- No known cardiac illness historically
- Absent signs of cardio-respiratory distress (cyanosis, use of accessory muscles)
- Absent severe palmar pallor
- Willing to participate in the research by taking written consent from the guardian
- Absent structural heart disease (valvular or congenital heart disease)

3.4 Data collection

Data was collected with involvement of trained health practitioners. Cases were assessed within 24 to 48 hours of admission by the clinical nurse under supervision from pediatrics resident, who were trained on the data collection procedures, to take the basic clinical data and blood sample collection for serum analysis of cardiac biochemical indicators (cardiac troponin, atrial and brain natriuretic peptide) which was interrupted with some technical and logistic issues to proceed on the non invasive approach.

Socio-demographic data was collected and history was cleared to be documented on a structured questionnaire after written consent was collected from the care giver. Left ventricular mass, Left ventricular dimensions, fractional shortening and ejection fraction was measured using two-dimensional echocardiography by trained echocardiographer. The controls also underwent the same pattern within the limits of the study period. The total duration of data collection was continued till the aforementioned sample was achieved.

Anthropometric measurements

Recumbent length for children < 2 y of age, standing height for children > 2 y, and weights were recorded using recommended techniques. Length and stature was recorded to the nearest 0. 1 cm. Weights for children < 2 y of age were recorded to the nearest 10 g and weights for children > 2 y were recorded to the nearest 0. 1 kg. Length or stature and weight were plotted on the National Center for Health Statistics percentiles to obtain age- and sex-adjusted measurements for cases. For controls we used the WHO simplified field table of WHO multicentre growth reference study. Then it was transferred to the WHO Anthro software to calculate Z scores for each. Mid upper arm circumference (MUAC) was measured midway between the tip of the acromion and the olecranon process on the relaxed right arm to the nearest 0.25 cm with a plastic tape. For quality assurance, all measurements were supervised by pediatric resident (23). Body surface area (BSA) was calculated using height/length and weight by the Haycock's formula (BSA (m^2) = 0.024265 x Height $(cm)^{0.3964}$x Weight$(kg)^{0.5378}$) which was used for calculating of LVMi as a ratio of LVM to BSA (24).

Tools/instruments used were:

a. ***Questionnaire***: Basic clinical data using structured questionnaires, the pediatric resident involved has used the usual tools for clinical diagnosis with special emphasis to anthropometric analysis.
b. ***Laboratory data:*** Whole blood from the consenting study population was taken, after cleaning with alcohol swab and drying, from the brachial vein using 18-20 gauge needles and was collected by citrate bottle. Two milliliters of blood sample was used for both hemoglobin/hematocrit as part complete blood count or stand alone.
c. ***Echocardiography***: Two dimensional and M-Mode echocardiographic examinations were performed to determine left ventricular systolic functions. Images were obtained with an HP Micromaxx Sonosite echocardiogram (Hewlett Packard Imaging Systems, Andover, USA) with 3.5/2.7 MHz and 5.0/7.5 MHz transducers. Recordings were performed with the child in supine and left lateral positions. M-Mode tracings were obtained at the level of the tips of the mitral leaflets in the parasternal long

axis position. The study from Brazil has revealed that there was Inter-observer variation verified in the Echocardiography Service as to be below 10% and intra-observer variation lower than 5% for the values of echocardiographic measurements used (25, 26). Having this notion we have tried to use echocardiographer, pediatric final year resident and for further clarity pediatric cardiologist with possible minimal intra-observer variation.

3.5 Design of Protocol

The protocol was designed to match the standard nutritional assessment protocols in classifying children at each specific group using the national and WHO guideline. The NCHS and WHO simplified field table of WHO multicentre growth reference study was used appropriately. Echocardiographic analysis was done with a portable machine calibrated and having a storage means if secondary thought is needed. The result was notified to the caring clinician up on the need of helping the treatment process.

3.6 Data analysis

The data on the left ventricular mass, LV mass index and left ventricular dimensions were recorded using EpiData 3.1. Data were expressed as mean ± standard deviation and presented with tables. Unpaired t-test was used from the online version of graphpad **QuickCalcs** (http://graphpad.com/). Significance was established at $P < 0.05$. SPSS, WHO Anthro, and EpiData were used in the other procedures (determination of means and standard deviations, Z score calculations, and data entry and clearance respectively).

3.7 Ethical consideration

The study had adhered to all parameters required by the ethical consideration board of Jimma University. Care takers of children participating in the study were informed of its purpose before obtaining their written consent to proceed with the research procedures.

Chapter Four

4. Results

A total of 45 children participated in the study of which 30 were having a diagnosis of severe acute malnutrition (15 edematous and 15 non edematous types; and the remaining 15 control. The mean ages for the cases were 2.4±1.7 years and for the control group was 3.3±1.8. Males accounted for 53.3% in the control group which is proportional to the cases. None of the study population was having structural or significant functional echocardiographic abnormality. (Table 1)

Table 1. Mean and standard deviation of selected features of children with severe acute malnutrition(SAM) and their controls

Socio-demography	SAM			Controls
	Edematous	Non-Edematous	Total	
Age ,y	3.3±1.5	1.5±1.2	2.4±1.6	3.2±1.8
Sex, Male*	8(53.3)	9(60.0)	17(56.7)	8(53.3)
Hematocrit, %	30.8±4.1	35.9±3.3	33.4±4.5	37.6±3.4
Body surface area, m^2	0.49±0.12	0.34±0.06	0.41±0.12	0.6±0.12

*n (%)

With regard to the echocardiographic based left ventricular mass, mass index and dimensions, left ventricular posterior free wall thickness and LV mass were reduced in the group with SAM (LV mass 29.2±13.9 Vs 44.4±13.4 P < 0.05). However, LV mass/body surface area ratio (LVMi, LV mass index) was not different in the patients with SAM and in the control group (69 ± 20.9 Vs 75.7 ± 10.4, P = 0.249). There was no difference between children with SAM and control group in terms of ejection fraction and fractional shortening (EF 65.5±9.3 Vs 67.1±5.6 **P=0.5443 and FS** 34.5±6.6 Vs 35.9±4.0 **P=0.4557**), which are the most widely used parameters in the evaluation of left ventricular systolic functions, (table 2).

Table 2. Mean and standard devaiton of SD echocardiographic function indices between Severe Acute Malnutrition (SAM) and control groups, JUSH, 2013

Function	SAM (n=30)	Control(n=15)	p-value*
LVM**	29.2±13.9gm	44.4±13.4gm	0.0001
LVMI	69±20.9	75.7±10.4	**0.2498**
LV dimension during systole	16.2±4.4mm	17.6±3.3mm	**0.2833**
LV dimension during diastole	22.9±5.5mm	27.5±4.6mm	0.0079
Fractional shortening	34.5±6.6	35.9±4.0	**0.4557**
Ejection fraction	65.5±9.3%	67.1±5.6%	**0.5443**
IV septum dimension during systole	7.8±1.7mm	9.1±1.1mm	0.0102
IV septum dimension during diastole	6.1±1.4mm	7.1±1.0mm	0.0178
LVPW dimension during systole	8.1±1.7mm	7.0±1.1mm	0.0281
LVPW dimension during diastole	5.9±1.7mm	9.4±1.5mm	0.0001

*Unpaired t-test is used

**LVM= Left Ventricular Mass; LVMi= Left Ventricular Mass index; IV=Interventricular; LVPW= Left Ventricular Posterior Wall; SD= Standard Deviation; mm= milimetre; gm= gram

Statistically significant difference was not observed for those patients with edematous SAM as compared to the controls except the posterior wall dimension during systole and diastole (8.8±1.8 Vs 7.0±1.1 P=0.0026). Unlike the whole group of children with SAM, isolated non edematous SAM children were having reduced Left ventricular mass index when compared to the controls (60.7±14.6 Vs 75.7±10.4 P=0.0031). In the same pattern ejection fraction and fractional shortening were not reduced among each group of cases as compared to the controls though slightly higher among non edematous groups than edematous ones [FS (E) = 33.8±7.2; FS (NE)= 35.2±6.1; FS (c)= 35.9±4.0 p>0.05)(table 3 and 4).

Table 3. Echocardiographic function indices between non-edematous Severe Acute Malnutrition (SAM) and control groups, JUSH, 2013

Function	Non-edematous SAM (n=15) Mean ±SD	Control(n=15) Mean ±SD	p-value*
LVM	20.6±6.2gm	44.4±13.4gm	0.0001
LVMI**	60.7±14.6	75.7±10.4	0.0031
LV dimension during systole	14.6±4.2mm	17.6±3.3mm	0.0382
LV dimension during diastole	19.8±5.2mm	27.5±4.6mm	0.0002
Fractional shortening	35.2±6.1	35.9±4.0	**0.7129**
Ejection fraction	66.9±8.4%	67.1±5.6%	**0.9394**
IV septum dimension during systole	7.2±1.5mm	9.1±1.1mm	0.0005
IV septum dimension during diastole	5.4±1.0mm	7.1±1.0mm	0.0001
LVPW dimension during systole	7.3±1.3mm	7.0±1.1mm	**0.5007**
LVPW dimension during diastole	5.2±1.1mm	9.4±1.5mm	0.0001

***Unpaired t-test is used**

**LVM= Left Ventricular Mass; LVMi= Left Ventricular Mass index; IV=Interventricular; LVPW= Left Ventricular Posterior Wall; SD= Standard Deviation; mm= milimetre; gm= gram

Table 4. Echocardiographic function indices between edematous Severe Acute Malnutrition (SAM) and control groups, JUSH, 2013

Function	Edematous SAM (n=15) Mean ±SD	Control (n=15) Mean ±SD	p-value*
LVM**	37.8±14.3gm	44.4±13.4gm	**0.2027**
LVMI	77.1±23.5	75.7±10.4	**0.8344**
LV dimension during systole	17.9±3.9mm	17.6±3.3mm	**0.8217**
LV dimension during diastole	26±3.9mm	27.5±4.6mm	**0.3436**
Fractional shortening	33.8±7.2	35.9±4.0	**0.3319**
Ejection fraction	64.1±10.2%	67.1±5.6%	**0.3266**
IV septum dimension during systole	8.4±1.7mm	9.1±1.1mm	**0.1914**
IV septum dimension during diastole	6.8±1.4mm	7.1±1.0mm	**0.5050**
LVPW dimension during systole	8.8±1.8mm	7.0±1.1mm	0.0026
LVPW dimension during diastole	6.6±1.9mm	9.4±1.5mm	0.0001

***Unpaired t-test is used**

**LVM= Left Ventricular Mass; LVMi= Left Ventricular Mass index; IV=Interventricular; LVPW= Left Ventricular Posterior Wall; SD= Standard Deviation; mm= milimetre; gm= gram

The two groups of SAM, edematous and non edematous were compared with each other for the aforementioned parameters. It was found that children with edematous SAM were having significantly higher LV mass, LV mass index, septal and posterior wall thicknesses. The indicators for systolic cardiac function, ejection fraction and fractional shortening, were not statistically significant between the two groups. But it was found to have better mean value with non edematous groups (FS 35.2±6.1 Vs 33.8±7.2 P value=0.5702 and EF 66.9±8.4 Vs 64.1±10.2 P value=0.4188) (Table 5) as compared to the edematous group.

Table 5. Echocardiographic function indices between non-edematous Severe Acute Malnutrition (SAM) and edematous PEM groups, JUSH, 2013

Function	Non-edematous SAM (n=15) Mean ±SD	Edematous SAM (n=15) Mean ±SD	p-value*
LVM**	20.6±6.2gm	37.8±14.3gm	0.0002
LVMI	60.7±14.6	77.1±23.5	0.0294
LV dimension during systole	14.6±4.2mm	17.9±3.9mm	0.0339
LV dimension during diastole	19.8±5.2mm	26±3.9mm	0.0009
Fractional shortening	35.2±6.1	33.8±7.2	**0.5702**
Ejection fraction	66.9±8.4%	64.1±10.2%	**0.4188**
IV septum dimension during systole	7.2±1.5mm	8.4±1.7mm	0.0498
IV septum dimension during diastole	5.4±1.0mm	6.8±1.4mm	0.0038
LVPW dimension during systole	7.3±1.3mm	8.8±1.8mm	0.0142
LVPW dimension during diastole	5.2±1.1mm	6.6±1.9mm	0.0199

***Unpaired t-test is used**

**LVM= Left Ventricular Mass; LVMi= Left Ventricular Mass index; IV=Interventricular; LVPW= Left Ventricular Posterior Wall; SD= Standard Deviation; mm= milimetre; gm= gram

Chapter Five

5.1 Discussion

Malnourished children suffer several 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, cardiomyopathy, cardiac failure and even sudden death (27, 28). According to most of the authors on cardiology in malnourished children, there is cardiac atrophy. The controversy on the other hand arises on whether or not this change is associated with left ventricular dysfunction (16, 29, 30, 31 and 32).

Echocardiographic studies in severely malnourished children have shown decreased LV Mass comparable to different studies (16, 29, 30, 32, 33, 34, and 35), it was also found that the ratio of LV Mass to body surface area did not show significant change. It was seen that LV dimensions during systole and diastole were not significantly affected rather left ventricular septal and posterior wall thickness were reduced significantly. That supports the assumption that the cause of diminished muscle mass in patients with severe acute malnutrition to be decreased myocardial tissue; which in turn points that the heart undergoes atrophy that affects other organs in those patients with SAM and it was proportional to the total body mass (32, 34, 36).

LV systolic and diastolic functions were preserved in atrophic hearts which is comparable to the study in in Tkirt (North-central Iraq) (34). In specific terms, Ejection fraction and FS, which are the most commonly used parameters in the clinical evaluation of systolic functions of the left ventricle, were not different in the group with SAM compared to control group. In other studys by Phornphatkul et al. and Nagla Hassan Abu Faddan et al. reported that children with PEM have cardiac muscle wasting and also ventricular dysfunction (32, 37). The other study by Singh et al. reported that left ventricular systolic functions were reduced especially in children with a loss in bodyweight of more than 40% of expected weight (36).

It was seen that the lowest mean value of ejection fraction and fractional shortening in cases of children with edematous severe acute malnutrition. In the absence of significant LV mass loss, it helps us think other possible causes to be entertained for the relative reduction in the systolic cardiac function as indicated by lowest level of EF and FS. This finding was comparable to the study in Turkey and Iraq (34, 38).

5.2 Limitation of the study

There was no biochemical analysis done that could have helped in detailing cardiac tissue injury markers. It is one of the standard procedures in studies where the prime target is determining cardiac function as a result of severe acute malnutrition. The other limitation in the process of recruitment of cases and controls was the modification in the organizational and accompanied changes in the Hospital system. It has reduced the number of cases arriving to the Hospital which possibly had affected the data collection process as it is time bounded data collection timing.

Chapter Six

6. Conclusion and recommendation

This study had revealed that there was cardiac atrophy from SAM, whether it is edematous or non-edematous type. But there was no change with regard to LV mass as indexed from body surface area. Though there was the documentation of cardiac atrophy, there was no significant reduction of systolic function of the heart. It has also revealed that the least measurement of mean systolic function among edematous SAM cases as compared to other groups under study without comparable change to the cardiac mass, which lets the thinking of other possible causes to be studied like micronutrient deficiencies and other metabolic changes

This study can be taken as a preliminary study that calls for further detailed study with inclusion of other biochemical approaches and prospectively determining the changes in the cardiac function with the nutritional therapy..

Chapter Seven

7.References

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