Study of The Cardiac Function of Children Aged from 6 to 59 Months Suffering from Severe Acute Malnutrition in Yaounde Cameroon

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ABSTRACT

Background: Malnutrition is a real public health problem in developing countries. The prevalence remains high in Cameroonian.

Context: This condition is regularly accompanied by organ failure. One of the most frequent and severe situations is cardiac involvement with implications on the management of patients. Describing the echocardiographic abnormalities of the heart function of children aged 6 to 59 months hospitalized for Severe Acute Malnutrition (SAM) in the hospitals of Yaoundé was the goal of this study. Knowledge of changes in heart function during the management of SAM will contribute to ameliorating the prognosis, which will also depend on the cardiac lesions.

Methods: It was a cross sectional descriptive study carried out in healthcare structures in the town of Yaoundé for a period of 5 months, from January to May 2015. Children aged 6 to 59 months suffering from severe acute malnutrition and hospitalized for at least 6 days were included. We excluded those who had a pathology which could influence heart function. Data collected covered the sociodemographic, clinical and echocardiographic characteristics of the study participants.

Results: Most of the 78 children recruited were less than 18 months old (81.08%). The sex ratio was 0.6. Marasmus was the most common type of SAM we found (78.38%). Concerning echocardiography, 35.14% of children had a left ventricular shortening fraction (LVSF) and a Left Ventricular Ejection Fraction (LVEF) less than the 3rd percentile. In all the patients, the speed of the E and A waves was less than -2SD of reference means. The ratio of the E/A waves was less than the 5th percentile in 35.14%. All had a Tricuspid Annular Plane Systolic Excursion (TAPSE) <-2SD of the reference mean. The decrease of the LVEF was significantly linked to the young age of the patients and to the degree of severity of the malnutrition.

Conclusion: severe acute malnutrition is associated with both systolic and diastolic heart failure. Functions of the two ventricles are altered. The severity of heart lesion depends on the degree of malnutrition.

Keywords
Heart function, Severe Acute Malnutrition, Children.

Background
Severe acute malnutrition remains a public health problem in developing countries [1]. Being one of the causes of mortality in Africa, it is one which policy find difficulties in apprehending and halting. Although the global mortality of children below 5 years in Africa has reduced by 14% since 1990, the number of malnourished children has kept increasing in Africa [1]. In Cameroon, the third
Severe malnutrition causes organ, system and even multivisceral failures of nutritional origin and intercurrent pathologies which could affect heart function to varying levels [4]. In view of the structural and functional impacts of cardiac lesions described by Ellis and al up to Amals and al in 2014, the median mortality rate due to SAM which is usually found between 30 and 50% can significantly reduce if the treatment took into account the multi organ physiological and metabolic changes observed during this illness [5].

This rate is particularly increased during the management of complications like severe anemia, dehydration, and during renutrition in the acute phase with the renutrition syndrome due to an acute heart failure. Taking into account the physiological and metabolic changes which occur in SAM implies particular treatments [5]. The goal of our work was to describe the frequencies and the types of echocardiographic abnormalities of heart function in children aged between 6 and 59 months hospitalized for SAM at the onset of the management in hospitals in Yaounde.

Study population
It was made of patients aged 6 to 59 months hospitalized for severe acute malnutrition, in the said hospitals for less than six days. They were included in the study after informed consent was obtained from their parents. We excluded children who were in a state of shock, those who presented with a chronic pathology which could have an impact on heart function (Congenital cardiopathies, pericarditis, valvulopathies, sickle cell anemia, HIV infection) as well as those having severe anemia.

Recruitment procedure
The recruitment of participants was consecutive during a random sampling. The size of the study population was limited to the number of patients who fulfilled our inclusion criteria. We pre-selected patients aged 6 to 59 months on the basis of anthropometric parameters and according to the criteria of the WHO defining Severe Acute Malnutrition [6].

Cardiac ultrasounds were done only on the eligible study participants. A device of the mark Accuson Cypress, Siemens with two multi-frequency cardiac probes: 3V2c(3.5/3.0/2.5/2.0 MHz) and 7V3c(7.0/6.0/5.0/3.5 MHz) was used. The same technician did all the heart ultrasounds which were all transthoracic in the TM, dimensional, pulse Doppler, continuous and color. The following incidences were systematically done on each eligible participant: sub-costal, para-sternal, large axis, para-sternal, small axis, 4 cavities apical, 5 cavities apical, and finally supra-sternal.

As for the appropriate incidence, the examination was done on patients in both the dorsal decubitus and the left lateral decubitus positions.

All the cardiac ultrasound measurements were done following the American Society of Echocardiography recommendations [7]. The systolic function of the left ventricle was evaluated by the Left Ventricular Shortening Fraction (LVSF), as well as the Left Ventricular Ejection Fraction (LVEF). It was the same thing for the diastolic function by the speed of the Mitral E and A waves and the E/A ratio.

As for the right ventricle, only its systolic function was evaluated by TAPSE. The echocardiographic parameters of each patient were compared to the reference central tendency values. The LVEF and the LVSF were considered as abnormal when they were out of the 3rd and 97th percentile (P3 and P97).

As for the values of the E and A waves, they were considered abnormal when they were out of the 5th and the 95thpercentiles (P5 and P95). The TAPSE was considered to be abnormal when it was less than the mean minus 2 standard deviations [8-10].

Statistical Analysis
The Epi Info version 3.5.3 was used to analyze the data. Quantitative variables were described using means ± standard deviation and
were compared using the Student’s test. Qualitative variables were expressed in the form of proportions. The comparison between different subgroups of variables was done using the Fisher test for categorical data. Probability values P<0.05 were considered to be statistically significant.

The analyses concerned sociodemographic (age in months, gender), clinical (vital parameters: heart rate, respiratory rate, blood pressure as well as the nutritional status: Weight for Height (W/H expressed in Z scores), the type of Severe Acute Malnutrition especially marasmus, kwashiorkor and kwashiorkor-marasmus). Anthropometric parameters were interpreted with the help of the WHO-Anthro software version 3.2.2. Concerning the heart function, the variables studied included: LVEF, LVSF, E wave, A wave, E/A ratio, TAPSE. The mean values of these variables were compared to vital parameters, to anthropometric indices W/H as well as to the type of malnutrition.

**Ethical considerations**

Our study obtained ethical clearance from the ethical committee of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé I. Informed consent of the parents was first of all obtained before any clinical or biological investigations were carried out on the children.

**Results**

During the period of study, 78 children aged 6 to 59 months and suffering from SAM were recruited. We excluded 41 of them who didn’t meet up with our criteria (30 for positive HIV serology, 01 for sickle cell, 07 for severe anemia with hemoglobin less than 4 g/dl and 03 for state of shock. Only 37 children were retained.

Almost all the patients had abnormal vital parameters. These were: Hypotension which was observed in 36 (97.3%) of children, abnormalities of the heart rate such as tachycardia in 14 (37.8%) patients and bradycardia in 22 (59.5%) children; abnormal respiratory rates which included tachypnea in 20 (54.1%) children and bradypnoea in 8 (21.6%) patients.

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### Table 1: Echocardiographic variables.

| Parameters    | Mean value ± SD | Total | Reference mean values | N    | Values compared to percentiles | P-value |
|---------------|-----------------|-------|-----------------------|------|--------------------------------|---------|
| LVEF (%)      | 65.95 ± 11,25   | 37    | 81,1 ± 0,69           | 13   | 35,14% < P3                   | 0,000   |
|               |                 |       |                       | 24   | 64,86% between P3 and P97     |         |
| LVSF (%)      | 39 ± 0,12       | 37    | 42,27 ± 0,65          | 13   | 35,14% < P3                   | 0,000   |
|               |                 |       |                       | 24   | 64,86% between P3 and P97     |         |
| Speed of the A wave (m/s) | 0,58 ± 0,18 | 37    | 3,25 ± 0,09           | 37   | 100% < P5                     | 0,000   |
| Speed of the E wave (m/s) | 0,92 ± 0,24 | 37    | 6,84 ± 0,82           | 37   | 100% < P5                     | 0,000   |
| E/A Ratio     | 1,69 ± 0,7      | 37    | 2,05 ± 0,21           | 23   | 62,16% between P3 and P95     | 0,000   |
|               |                 |       |                       | 1    | 2,7% > P95                    |         |
| TAPSE (cm)    | 1,19 ± 0,35     | 37    | 3,38 ± 0,39           | 37   | 100% < mean-2SD               | 0,000   |

#### Table 2: Comparison between echocardiographic parameters and age.

| Parameters           | 6-11 months | 12-17 months | 18-23months | 24-60 months |
|----------------------|-------------|--------------|-------------|--------------|
|                      | N       | %   | N   | %   | N   | %   | N   | %   |
| LVEF (%)             | <P3      | 5   | 13,5 | 3 | 8,1 | 2 | 5,4 | 3 | 8,1 |
| LVSF (%)             | <P3      | 10  | 27,03 | 2 | 5,4 | 2 | 5,4 | 4 | 10,8 |
| Speed of E wave (%)  | <P5      | 19  | 51,3 | 11 | 29,7 | 2 | 5,4 | 5 | 13,5 |
| Speed of A wave (%)  | <P5      | 19  | 51,3 | 11 | 29,7 | 2 | 5,4 | 5 | 13,5 |
| E/A Ratio            | <P5      | 14  | 37,84 | 6 | 16,2 | 0 | 0,0 | 3 | 8,1 |

#### Table 3: Comparison between echocardiographic parameters and the W/H index (z-score). *: P<0.05.

| Parameters           | -9 ≤ W/H < -5 (n=12) | -5 ≤ W/H < -4 (n=9) | -4 ≤ W/H < -3 (n=16) |
|----------------------|-----------------------|---------------------|-----------------------|
|                      | N   | %   | N   | %   | N   | %   |
| LVEF (%)             | <P3 | 05  | 41,67* | 01 | 11,11 | 07 | 43,75 |
| LVSF (%)             | <P3 | 05  | 41,67* | 02 | 22,22 | 06 | 37,50 |
| Speed of E wave (%)  | <P5 | 12  | 100   | 09 | 100   | 16 | 100  |
| Speed of A wave (%)  | <P5 | 12  | 100   | 09 | 100   | 16 | 100  |
| E/A Ratio            | <P5 | 05  | 41,67 | 01 | 11,11 | 07 | 43,75 |
| TAPSE (mm)           | < moy-2ET | 12  | 100 | 09 | 100 | 16 | 100 |

#### Table 4: Association between the type of malnutrition and echocardiographic parameters.
P*: P-value comparing patients with kwashiorkor and those with marasmus.
P**: P-value comparing patients with kwashiorkor and those with kwashiorkor-marasmus.
P***: P-value comparing patients with marasmus and those with kwashiorkor-marasmus.
Discussion
The goal of our work was to describe the echocardiographic abnormalities of heart function in children 6 to 59 months old suffering from SAM in Yaoundé. Our patients were generally young (81.1% were less than 18 months old). The majority of the children in our sample were suffering from marasmus. Marasmus generally occurs early in life, usually in the first year of life [11]. The female sex was more represented. This female predominance however seemed to have occurred by chance. In fact, there wasn’t supposed to be any difference in the occurrence of malnutrition according to the gender [12]. Whatever the gender, it is in poor homes that children run the highest risk of suffering from malnutrition. In Cameroon moreover, the male sex are slightly more affected by SAM [13].

Our study population was largely dominated by children suffering from marasmus. Marasmus is in fact the most common type of SAM [14]. We found hypotension in almost all our study participants. Severely malnourished children are generally dehydrated, which causes a significant decrease in the circulating blood volume, which results in hypotension. Keerpelfronius and col, in a study on the circulatory dynamics of malnourished children, found a decrease of up to 25 mm Hg of blood pressure in 40% of study participants in function of the severity of malnutrition [15]. Abnormalities of the heart rate and respiratory rate were also frequent findings. In addition to the acceleration of cardiac rhythm to restore the cardiac output in situations of hypovolemia, patients suffering from SAM experience a significant autonomic nervous system changes, as a function of the type and the severity of the illness [16]. Srivastava and col in India found a sympathetic hyperactivity in children with SAM which was clinically reflected by tachycardia [17]. But Srivastava’s team had as study population patients suffering from mild and moderate acute malnutrition. Ocal and col found a predominance of bradycardia in marasmic patients, which ties with our results in which 59.5% of patients presented with bradycardia [18]. In fact, in our study marasmus represented 78.38% of cases of SAM. Other authors have in the past reported in other case series a combination of bradycardia and tachycardia [19].

The mean of the LV systolic function was generally lower than the reference mean. Over a third of patients (35.14%) had LV systolic function frankly to below normal. In addition, the alteration of the LV systolic function was associated with the severity of the SAM. The SAM is responsible for disturbances in body composition including the loss of skeletal and cardiac muscle causing heart failure [18, 20]. All patients of our study had speed of the mitral E and A waves less than the 5th percentile. In 35.14%, the E/A ratio was below the 5th percentile. The speeds of the E and A waves and the E/A ratio have presented a significant difference with the mean of the values of central tendencies of the reference tables for each variable (p<0.05).

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