A Study of Some Echocardiographic and Some Physiological Changes in Malnourished Children

Saad Merza Al-Aaraji [(a)] Yahya A. Al-Tufaily[(a)]
Hawraa Saleem Abd AL-Ameer[(b)]
[(a)] Collage of Medicine, University of Babylon, Hilla, Iraq.
[(b)] Babylon Health Directorate, Babylon, Hilla, Iraq.

Abstract

The aim of the present study was to detect the frequency of myocardial damage in malnourished children as shown by echocardiography also to detect some other hematological, biochemical and electrolyte abnormalities that occur in malnourished children and may also, by way or another, have effect on the heart.

The study include 104 patients, (40 male and 64 female), malnourished infants and young children diagnosed by special pediatrician during the period extended from November 2011 to May 2012. The patients were recruited from the inpatient department and nutritional rehabilitation unit in the Babylon Pediatric and Maternity Hospital. The age of patients (mean ± SD) was 11.3 ± 7.8.The patients were matched with 20 apparently healthy controls their age (mean ± SD) was9.5 ± 7.6.

All patients underwent full history ,detailed physical examination, Hematological, Biochemical and echocardiographic evaluation.

The study show that there are many alterations in body composition of malnourished children, these alterations were statistically significant regarding weight, mid arm circumference, body mass index, hematological tests , biochemical tests.

Regarding myocardial changes there were statistically significant increment in end systolic dimension (16.07mm ± 7.3SD) and decrement in fractional shortening (38mm ± 0.87SD) in malnourished children. The end diastolic dimension although it was higher in malnourished children (24.7mm ± 7.2SD) however it was statistically not significant.

All patients with significant increase in end systolic dimension were in grade III (severe malnutrition), however patients with significant decrease in functional shortening were distributed in grade II (moderate) and grade III (severe) malnutrition.

We conclude from this study that malnutrition can affect myocardial function although this effect appear clearly only in high grade of malnutrition, and also the higher the grade of malnutrition the more the effect on the myocardium.

الخلاصة

إن الهدف من هذه الدراسة هو الكشف عن وجود تلف في عضلة القلب لدى الأطفال الذين يعانون من سوء التغذية كما يتضح من خلال إجراء تخطيط صدى القلب و كذلك أيضا للكشف عن بعض التغيرات الدموية و البايوكيميائية التي تحدث في الأطفال الذين يعانون من سوء التغذية، و التي تؤثر، بشكل أو بآخر على عضلة القلب.

اشتملت الدراسة على ١٢٤ طفل منهم ١٠٤ طفل كمجموعة المرضى (والذين تم تشخيصهم كأطفال مصابين بسوء التغذية من قبل أخصائي طب الأطفال) و ٢٠ طفل من الأطفال الأصحاء كمجموعة السيطرة، توزعت مجموعة المرضى بين ٤٠ طفل من الذكور و ٦٤ طفل من الإناث، تمت الدراسة خلال الفترة الممتدة من كانون الأول ٢٠١١ إلى أيار٨٩– ٢٠١٢. تم اخذ المرضى من قسم المرضى الداخلين أو المراجعين إلى وحدة التأهيل التغذوي في مستشفى بابل للولادة والأطفال وكان عمر المرضى (متوسط ± SD) 7.8 ± 11.3شهر في ما كان عمر مجموعة السيطرة (متوسط ± SD) 7.6 ± 9.5 شهر.

تم اخذ التاريخ المرضي الكامل لجميع الأطفال وكذلك تم إجراء الفحص البدني (الوزن، الطول، محيط منتصف الذراع العلوي ومؤشر كتلة الجسم). خضع جميع الأطفال إلى التحاليل المختبرية والإشعاعية التالية :خضاب الدم، مكداس الدم، عدد خلايا الدم الحمراء، معدل ترسب كريات الدم الحمراء، عدد خلايا الدم البيضاء، اليوريا في الدم، الكرياتينين في مصل الدم ، مجموع البيليروبين في مصل الدم، البروتين الكلي والألبومين في مصل الدم والحديد في مصل الدم وكذلك إجراء تخطيط صدى القلب.

أظهرت الدراسة إن هناك تغييرات كثيرة في تكوين الجسم عند الأطفال الذين يعانون من سوء التغذية، و كانت هذه التغييرات ذات دلالة إحصائية هامة حيث كان هناك نقصانا "معنويا" فيما يتعلق بالوزن، محيط منتصف الذراع ومؤشر كتلة الجسم، واختبارات الدم (مكداس الدم، خضاب الدم ، خلايا الدم الحمراء)،واختبارات الكيميائية الحيوية (اليوريا في الدم، الكرياتينين ، البوتاسيوم والحديد في مصل الدم، ومجموع البروتين و الألبومين في مصل الدم فيما كانت هناك زيادة "معنوية" في خلايا الدم البيضاء ومعدل ترسب كريات الدم الحمراء.

فيما يتعلق بتغييرات عضلة القلب كانت هناك زيادة "معنوية" ($P<0.05$) فيما يتعلق ببعد البطين الأيسر الانقباضي (7.3SD ± 16.07mm)، وتناقصا "معنويا" ($P<0.05$) في التقلص الوظيفي (0.87SD ± 38mm) في الأطفال الذين يعانون سوء التغذية مقارنة بأقرانهم من مجموعة السيطرة فيما لم يكن بعد البطين الأيسر النهائي الانبساطي ذات دلالة إحصائية هامة .

كذلك بينت الدراسة إن جميع المرضى الذين يعانون من زيادة كبيرة في بعد البطين الأيسر الانقباضي النهائي كانوا يعانون من سوء التغذية من الدرجة الثالثة ، أما المرضى الذين يعانون من انخفاض كبير في التقلص وظيفي فقد توزعوا في الدرجتين الثانية (معتدل)، و الثالثة (شديد) من سوء التغذية.

نستنتج من هذه الدراسة أن سوء التغذية يمكن أن تؤثر على وظيفة عضلة القلب على الرغم من أن هذا التأثير لا يظهر بشكل واضح إلا في الدرجة الثالثة (الشديدة) من سوء التغذية، وهذا يدل على انه كلما زادة شدة سوء التغذية كلما كان التأثير على عضلة القلب أكثر.

Introduction

The term malnutrition generally refers both to under nutrition and over nutrition[1]. In this guide the use term malnutrition refer solely to a deficiency of nutrition.

Malnutrition that is the direct cause of death is referred to as "protein-energy malnutrition"(PEM).This occurs when there are no sufficient amounts of protein and calories in diet .Protein is needed to support the function of muscles, cells, tissues and organs [2].The calories provided the energy for cells, movement, thought and memory.[3]

The term protein energy malnutrition covers a wide spectrum of clinical stages ranging from the severe forms like kwashiorkor and marasmus to the milder forces in which the main detectable manifestation is growth retardation. It is widely prevalent among weaned infants and pre-school children in developing countries.[4]

Many factors can cause malnutrition, most of which relate to poor diet and repeated infections, particularly in underprivileged populations. Inadequate diet and disease, in turn, are closely linked to the general standard of living, the environmental conditions, and whether population is able to meet its basic needs such as food, housing and health care. [5,6] The growth of infants and children throughout the world is related to the socio-economic environment in which they live [7].

Moderate malnutrition includes all children with moderate wasting, defined as a weight-for-height between –3 and –2 z-scores of the World Health Organization (WHO) child growth standards, and all those with moderate stunting, and defined as a height-for-age between –3 and –2 z-scores of the WHO child growth standards. [8]

A recent analysis of data from 388 national surveys from 139 countries including our country,(Iraq) from 2005 has provided an estimate

that about 36 million children aged 6 to 59 months are suffering from moderate wasting. Approximately 178 million are estimated to be stunted. [6]

Moderate malnutrition increases the risk of death from common diseases and, if not adequately treated, may worsen, resulting in severe acute malnutrition (sever Wasting and/or edema) and/or severe stunting (height for-age < –3 z-scores), which are both life-threatening conditions.[9] Therefore, the management of moderate malnutrition is a public health priority. Child malnutrition was associated with 54% of child deaths (10.8 million children) in developing countries in 2001.[10]

In contrast to severe malnutrition, programs for the management of moderate malnutrition in children have remained virtually unchanged for the past 30 years, although it seems likely that this form of malnutrition is associated with a larger proportion of nutrition-related deaths than severe malnutrition.[11]

Failure to thrive (FTT) is both a descriptive term for various entities and a diagnosis. It is defined as a significant interruption in the expected rate of growth during early childhood. Because sequential measurements of growth are vital aspects of preventive pediatrics, failure to thrive is a concern for all pediatric health care providers. [12-17]

Materials and Methods

Patients and Control Groups:

The current study included 104 malnourished infants and young children diagnosed by special pediatrician during the period extended from November 2011 to May 2012. The patients were recruited from the inpatient department and nutritional rehabilitation unit in the Babylon Pediatric and Maternity Hospital. The ages of the patients ranged from 1 to 36 months. There were 40 male and 64 female. The patients group divided in to three grade according to the severity of malnutrition, grade I (mild) 8 children, grade II (moderate) 32 children and grade III (severe) 64 children.

Exclusion criteria were the following:

1. Pre-term infants or intrauterine growth retardation at birth.
2. Congenital heart disease .

Control Groups:

The control group consist of 20 apparently healthy infants and young children. Their age ranged from 1 to 36 months. Of them 6 boys and 14 girls.

Patients and control were subjected to the following investigations:

1. Serum albumin.
2. Serum Iron.
3. Serum Potassium.
4. Serum Total Protein.
5. Total Serum Bilirubin.
6. Blood Urea.
7. Serum creatinin.
8. Complete blood picture and blood film.
9. Chest X-Ray.
10. Echocardiograph.

Methods:

All the patients and control groups were assessed clinically, haematologically, biochemically, radiologically and by echocardiography as following:

Clinical assessment:

History:

Before nutritional rehabilitation, all studied malnourished infants were subjected to full history taking, including: personal data like name, age, sex, residence, type of feeding (breast, bottle, mixed, other), the baby (term, preterm), and history of blood transfusion.

Physical Examination:

Thorough clinical examination, with special emphasis on the anthropometric measurements (weight

,length, mid arm circumference and calculation of BMI.), signs of malnutrition (pallor, edema, glossitis, angular stomatitis, wasting ,dermatitis) and examination for the presence of organomegally (liver and spleen).
The reference value of height and weight were compared to the growth charts of world health organization .

Echocardiographic Evaluation:

All patients underwent transthoracic echocardiographic examination after receiving an oral syrup as hypnotic drug(chloral hydrate) in a dose of 50 mg / kg, using the Hewlett Packard (HP) sonos 4500 using phased array transducers with a frequency of 8 MHZ. Imaging was performed with the patient in a recumbent or lateral decubitus position. M-mode echo is a standard method for assessment of left ventricular function in the absence of segmental wall motion abnormalities,[18-20], which was the case in the present study, and therefore M-mode, 2-dimensional echocardiography, pulsed and continuous wave Doppler and color flow mapping were performed in every patient using the standard views as parasternal long axis, short axis, apical four, five chamber and subcostal views to assess the following parameters:
a) Left Ventricular dimensions: measured from the derived M-mode echocardiography in the parasternal long axis view. All the tracings were recorded using the leading-edge technique.[21]
b) Percentage of factional shortening (FS): Left ventricle factional shortening (LV FS) was calculated using the following formula:
FS=EDD-ESD/EDD×100%
where, EDD is the end diastolic diameter of the left ventricle and ESD is the end systolic diameter of the left ventricle.

Results

Echocardiographic Test:

The study show that some Echocardiographic finding changed significantly in malnourished children as compared with healthy control children. The mean of End Systolic Dimension (ESD) in malnourished children was 16.07 ± 7.3mm while in control it was 12.14 ± 5mm (P< 0.05).The mean of Functional Shortening (FS.) was38 ± 0.87 (%) for patients and 49 ±0. 6 (%) for control (p<0.05). However although the End Diastolic Dimension (EDD.) was higher in the patients group(24.7 ± 7.2 mm) than in control group the relationship was not significant between the two groups (P > 0.05) (Table, 1).

Table 1 Echocardiographic findings of the malnourished children compared with control.

Variable	ESD. (mm). Mean ± SD.	EDD. (mm). Mean ± SD.	FS. (%). Mean ± SD.
Patients	16.07 ± 7.3*	24.7 ± 7.2	38 ± 0.87*
Controls	12.14 ± 5	22.5±7.7	49 ±0. 6

*significant (P < 0.05).
SD.: Standard Deviation.
ESD.: End Systolic Dimension.
EDD.: End Diastolic Dimension.
FS.: Functional Shortening.

When we compare the Echocardiographic finding among the different grades of the patients the FS. was significantly higher in grade I (mild) malnutrition than moderate (grade II) and severe (grade III) malnutrition ($p<0.05$). While the ESD was only significant between mild (grade I) and severe (grade III) malnutrition, the EDD was not significant among the all groups (Table, 2).

Table 2 Echocardiographic findings of the patients with Protein Energy Malnutrition according to their grade.

Variable	Number	ESD (mm).mean±SD.	EDD (mm)mean±SD.	FS. (%)mean±SD.
Mild (I)	8	12.25 ± 4.62*(B)	21.75 ± 6.20	45 ± 0.85*(A,B)
Moderate(II)	32	15.80 ± 6.48	25.04 ± 7.16	38 ± 0.87*(B,C)
Sever (III)	64	17.68 ± 7.07*(C)	25.61 ± 8.57	31 ± 0.43*(C)
Controls	20	12.14 ± 5	22.5±7.7	49 ±0. 6

*significant ($P < 0.05$).
(A) significant with group II (moderate)
(B) significant with group III(severe) .
(C) significant with control group .
SD.: Standard Deviation.
ESD.: End Systolic Dimension.
EDD.: End Diastolic Dimension.
FS.: Functional Shortening.

Discussion

Echocardiographic Test

Malnutrition is a serious disease responsible for high morbidity and mortality rates among children in developing countries.[22] Children suffering from severe malnutrition frequently exhibit cardiovascular abnormalities.[23]

Echocardiographic evaluation of children with malnutrition in the present study revealed a significantly higher End Systolic Dimension (ESD) in malnourished children (mean level 16.07 ± 7.3mm) than that of control children (12.14 ± 5mm), were as the Fractional Shortening (FS) was significantly lower than that of control children (mean level of patient 38 ± 0.87) (mean level of control 49 ±0. 6) (Table,1)

These findings are in agreement with those of previous authors [23] and [24] who reported that in patients with malnutrition, the heart is unable to escape from atrophy affecting other organs. suggested that the cause of diminished cardiac mass in patients with malnutrition was slow myocardial anabolic rate rather than increased catabolism.

The present study showed that the parameters of the (ESD), (FS) were significantly affected in patients than in the controls and this affection was more

prominent in moderately and severely malnourished patients (Table, 2).

This is in agreement with reports from previous authors [25] Kothari who reported that LV systolic function was reduced in children with severe cases of malnutrition with more than 40% loss of the expected weight.[26] Shoukry reported that infants with severely malnourished had a reduction in the FS compared with the controls.

Others , Gray [24] and El-Sayed [27] did not find any evidence of LV systolic dysfunction in their patients. This difference possibly could be due to the effect of other factors such as electrolyte imbalance or trace element deficiency that affect LV systolic function in the different studies.

Regarding the LV diastolic function ,the present study showed non significant difference between patients and the control group .These findings are in keeping with those reported by other studies, El-Sayed and Öcal. [27,28]

References

1. Fishman, S.; Caulfield, L.E.; Blossner, M.; Mullany ,L.; Black, R.E.(2004). Childhood and maternal underweight. In: Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors. Geneva, World Health Organization.
2. de Onis, M.; Monteiro, C.A.; Akre, J.; Clugston, G.(2002).The worldwide magnitude of protein-energy malnutrition: an overview from the WHO Global Database on Child Growth. Bulletin of the World Health Organization, 71:703−712.
3. Steven, M.; Sheffrin,G. (2003). Economics: Principles in action. Upper Saddle River, New Jersey 07458: Pearson Prentice Hall. pp. 481.
4. Khor ,G.L. (2003). Update on the prevalence of malnutrition among children in Asia. Nepal Med Coll J, 5:113-122.
5. Kilic, M.; Taskin, E.; Ustundag, B.; Aygun, A.D.(2004). The evaluation of serum leptin level and other hormonal parameters in children with severe malnutrition. *Clin Biochem*.;37(5):382-7.
6. Black, R.E.; Allen, L.H.; Bhutta, Z.A.(2008). Maternal and child undernutrition: global and regional exposures and health consequences. 371:243– 60.
7. Blair, P.S.; Drewett, R.F.; Emmett, P.M.(2004). Family, socioeconomic and prenatal factors associated with failure to thrive in the Avon Longitudinal Study of Parents and Children (ALSPAC). Int J Epidemiol ; 33:839.
8. World Health Organization (WHO).(2009). Management of severe malnutrition: a manual for physicians and other senior health workers.Availableat:http://www.who.int/nutrition/publications/severemalnutrition/en/manage_severe_malnutrition_eng.pdf.
9. de Onis, M.; Blössner, M.; Borghi, E.; Frongillo, E.; Morris, R .(2004). Estimates of global prevalence of childhood underweight in 1990 and 2015. *Journal of the American Medical Association*, 291:2600−2606.
10. World Health Organization (WHO).(2004). Inheriting the world. The atlas of children's health and the environment. Geneva, World Health Organization.
11. Blakely, T.; Hales, S.; Woodward, A .(2004). Socioeconomic status: assessing the distribution of health risks by socioeconomic position at national and local levels. Geneva, World Health Organization (WHO Environmental Burden of Disease Series, No. 10).
12. Pelletier, D.L.; Frongillo, E.A.; Schroeder, D.G.; Habicht, J.P. (1995). The effects of malnutrition on child mortality in developing countries. *Bull World Health Org*.;73 (4):443-8.

13. Emery, P.W. (2005). Metabolic changes in malnutrition. *Eye*.;19 (10):1029-32.
14. Akuyam, S.A.; Isah, H.S.; Ogala, W.N.(2008).Serum lipid profile in malnourished nigerian children in zaria. *Niger Postgrad Med J*.,15 (3):192-6.
15. Joosten, K.F. Hulst, J.M. (2008). Prevalence of malnutrition in pediatric hospital patients. *Curr Opin Pediatr*.;20(5):590-6.
16. Lazzerini, M.& Ronfani, L. (2008). Oral zinc for treating diarrhea in children. *Cochrane Database Syst Rev*.;(3):CD005436.
17. Pawellek, I.; Dokoupil, K.; Koletzko, B. (2008). Prevalence of malnutrition in paediatric hospital patients. *Clin Nutr*.;27(1):72-6.
18. Taksande ,A.; Vilhekar, K.; Jain, M.; Ganvir, B.(2005). Left ventricular systolic and diastolic functions in patients with sickle cell anemia. *Indian Heart J*.;57:6947.
19. Khositseth, A.; Suthuvoravut, U.; Chongviriyaphan, N.(2006). Cardiac dimentions and function in children with obesity. Indian Heart J.;58:422–5.
20. Salem, M.; El Behery, S.; Adly, A.; Khalil, D.; El Hadidi, E.(2009). Early predictors of myocardial disease in children and adolescence with type 1 diabetes mellitus. Pediatr Diabetes.; 10:513–21.
21. Feigenbaum, H.; Armstrong ,W.F.; Ryan ,T.(2005). Textbook of Echocardiography editors. 6th ed. USA: Lea and Febiger; pp. 68–173
22. Abo-Shousha, S.A.; Hussein, M.Z.; Rashwan, I.A (2005). Production of pro 29.
inflammatory cytokines: Granulocyte-macrophage colony stimulating factor, interleukin-8 and interleukin-6 by peripheral blood mononuclear cells of protein energy malnourished children. *Egypt J Immunol.;12:12531*
23. Olivares, J.L.; Vazquez, M. Rodrguez, G. (2005). Electrocardiographic and echocardiographic findings in malnourished children. J Am Coll Nutr. 24:38–43
24. Gray, V,B.; Cossman, J.S.; Powers, E.L.(2006). Stunted growth is associated with physical indicators of malnutrition but not food insecurity among rural school children in Honduras. Nutr Res.;26:549–55.
25. Kothari, S.S.; Patel, T.M.; Shetalwad, A.N.(2004). Left ventricular mass and function in children with severe protein energy malnutrition. *Int J Cardiol*. 35:19–25.
26. Shoukry, I.; Shoukry, A.S.; Ibrahim, M.M. (2006).Cardiac atrophy and ventricular function in infants with protein calorie malnutrition. In. Pediatric cardiology. Vol 44. New York: Springer Verlag;. pp. 1169–71
27. El-Sayed, H.L.; Nassar, M.F.; Habib, N.M. (2006). Structural and functional affection of the heart in protein energy malnutrition patients on admission and after nutritional recovery. *Eur J Clin Nutr*. 60(4):502-10.
28. Öcal, B. Ünal, S.; Zorlu, P.; Tezi, H.T.(2001). Echocardiographic evaluation of cardiac functions and left ventricular mass in children with malnutrition. *J Paediatr Child Health*. 37:14–7.