Med. J. Cairo Univ., Vol. 62, No.1, March (Suppl.): 247-256, 1994.

Evaluation of Serum Alkaline Phosphatase as A Biochemical Indicator of Growth Impairment in Parasitically Infected Children

IMAN EL-ASHMAWY, Ph.D. and SOHAIR BASSIONI, M.D.
The Child Health Department, National Research Center

Abstract

In this study the response of alkaline phosphatase as a biochemical indicator of impaired growth in parasitically infected Egyptian children was evaluated. To achieve this goal, fifty children infected with parasites and twenty normal healthy children were recruited for this study from the Health Unit of Kata Village, Giza Governorate. Their age ranged from 7-12 years. All children were subjected to clinical examination, and to anthropometric measurements that included weight and height. Blood sample was taken from each child and was tested for liver enzymes as aspartate amino - transferase (GOT), and alkaline phosphatase (ALP), and for albumin level. The parasitically infected children were further classified according to type of parasite into Giardiasis, Amoebiasis and Ascariasis. Results of our study showed that, the infected children, compared to normal controls, had a highly significant reduction in mean weight age and height/ age. Giardiasis associated cases with least Z-score for weight are and height/ age, ascariasis and amebiasis come next to that respectively. GOT, GPT and ALP serum levels shown in both parasitically infected and control groups were within normal ranges. A gradual decline in ALP mean level was demonstrated, going from cases with high Z-scores (Category III) for both weight and height/age to those with lowest Z-scores (Category I). Similar observation was well shown for albumin levels in the three categories. This work demonstrated how the type of parasite is implicated in producing a state of malnutrition. It as well showed that alkaline phosphatase could be used as a significant biochemical indicator for growth impairment.

Introduction

ASSESSMENT of impaired growth in children usually resides in anthropometric measurements, primarily weight/ age and height/ age. A simple indicator of bone growth in malnourished children is lacking alkaline phosphatase (ALP) level in plasma originates mainly in the liver, but in growing children is formed in large amounts by actively functioning osteoblasts i.e. the main source is bone [1]. In these children serum level of ALP is twice as the normal level [2]. Generally, ALP serum level was suggested to be of clinical value mainly in the study of patients with diseases of two systems: 1) The skeleton and 2) The liver and the biliary tract [3]. Accordingly, in children with impaired growth, ALP level is expected to be reduced. An example of children with impaired growth are those infected with parasites.

Children infected with parasites are exposed to a state of malnutrition since parasites that reside in the alimentary tract cause damage of the intestinal mucosa, interfere with nutrient absorption and loss of nutrients [4]. The extent of growth impairment in these children may depend on the type of parasite. To exclude the impact of any liver disease on the production of ALP, plasma level of liver enzymes as aspartate amino-transferase (GOT) and alanine amino transferase (GPT) were assessed as well.

Material and Methods

Fifty children with age range between 7-13 years were recruited from the Health Unit of Kata Village, Giza Governorate. The children were preliminary diagnosed by the laboratory technique of the health unit to be infected with parasites.

Twenty adult children of the same age range were simultaneously recruited, and they were healthy and not infected with any parasites and were chosen as controls.

On the day of admission to the health unit, clinical examination was carried out to assure that all the children were free from any disease.

Anthropometric measurements that included weight and height were measured, the landmarks instruments and techniques for measuring weight and height followed were those recommended by the international Biological Programme (I. B. P.) [5]. Fresh stool sample was collected and a 5 ml venous blood sample was withdrawn from each children before 12 A. M.

Both stool and blood sample were transported to the child health of NRC under cooling conditions. Stool analysis was carried out on the same day by using the two methods:

(a) Direct smear method.

(b) Concentration method [6]

Serum was separated and was analyzed on the next day for GOT, GPT, ALP. and Albumin using the Bio-Analytics kits.

Statistical Analysis

For weight and height, the values were compared to the standards of the National center for Health Statistics (NCHS) [7]. And the Z-score was calculated according the following formula: Z-score = (Standard's mean value-value of subjects/ standard deviation of standard). (Anthropometric standards for the assessment of growth and nutritional status, 1990).

The standards of the Z-score for each of the weight and the height were classified into 5 categories [8]. All the values for infected children were within the lowest three categories, that ranged from Z-score <-1.650 for category I,

- 1.645 < Z-1.040 for category II and
- 1.036 < Z < + 1.030 for category III.

For the control group the children Z-score ranged from -1.30 to + 1.04 and -0.67 to + 1.40 as regard the height and weight respectively. For these calculations we used the Anthro Program Version 1.01 [9].

Accordingly, the type of parasites and the levels of the biochemical data in the infected children were grouped into the above three categories.

T Student test for the difference between the means as well as Pearson correlation between the difference parameters were calculated [10].

Results

This study included twenty cases of giardiasis 9 Males and 11 females, fifteen cases of amoebiasis 8 Males and 7 females, and fifteen cases of ascariasis 11 Males and 4 females. The control group consisted of twenty healthy cases distributed as eleven males and nine females (Table 1).

Differences in the anthropometric measurements between parasitically infected and non-infected children are shown in table (2). Z-score was used to express growth and nutritional status of children. Mean weight per age Z-score and height per age Z-score in the parasitically infected group were -1.46 (0.55) and -1.45(0.89) in comparison to 0.5 (0.38) and 0.47 (0.41) in the control groups.

Mean body mass index (BMI) in the parasitically infected group was 14.98 (1.7) as compared to 17.91 (1.9) in the control group.

The statistical differences between the means of weight and height Z-scores and BMI of the two groups were highly significant ($p < 0.001$).

Table (3) showed that mean of each of albumin, GPT, GOT and ALP in different parasitic infections as well as in the control groups. The mean level of albumin, alanine amino transferase (GPT), aspartate amino transferase (GOT) and alkaline phosphatase (ALP) were 3.34 (0.52), 13.7 (3.0), 11.13 (1.9), 50.9 (14.14) in the whole parasitic group as compared to 4 (0.3), 10 (1), 9.7 (9.0) and 95.9 (21) respectively in the control group although the mean levels of the liver functions tests in the two groups were within reference

values, the statistical comparison between the two groups was highly significant ($p < 0.01$).

Tables (4 & 5) show the categorization of the parasites and their biochemical data according to the three categories of the Z-score as follows :

Category I = Z < -1.650
Category I I = -1.645 < Z < -1.040
Category III = -1.036 < Z < 1.030

Results showed that there was gradual increase in both albumin and ALP levels in going from category I to category III for both W/A Z-score and H/A Z-score (Tables 4 & 5).

Table (1) Distribution of Mean Age and Sex among Cases Infected with Different Parasites as well as Control Group

Cases	No.	Age (in years ± S.D)	Sex	
			Males	Females
* Group with Giardiasis	20	8.6 (105)	9	11
* Group with Amoebiasis	15	9.1 (1.0)	8	7
* Group with Amoebiasis	15	9.5 (1.5)	11	4
Total (infected cases)	50	9.7 (1.5) (range 7-12)	28	22
* Control group	20	9.6 (1.7) (range 7 - 12)	11	9

Table (2) Comparison of the Anthropometric Measurements between Group Infected with Parasites and Control Group.

Groups	No. of Cases	weight (kg)	Height (cm)	Height / Age Z.Score (HAZ)	Height / Age Z.Score (HAZ)	Body Mass Index (BMI)
* Group with parasite	50					
- Mean ± 80		24.4 (3.9)	127.5 (5.9)	- 1.45 (0.89)	- 1.46 (0.55)	14.9 (1.7)
- Range		17 to 39	117 to 140	- 3.77 to - 0.39	- 2.03 to - 0.48	11.8 to18.8
* Control group	90					
- Mean ± 80		33.9 (7.6)	135.2 (9.9)	0.47 (1.04)	0.5 (0.38)	17.9 (1.9)
- Range		99.5 to48.0	120 to 149	- 1.30 to+ 1.04	- 0.67 to+ 1.45	14.3 to21.6
* T values		6	4	4	7	6.36
* p level		$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$

Table (3): Biochemical Data of Groups Infected with Different Parasite as well as Control Group.

Cases	No. of cases	Albumin g/l		Gpt (ALT) u/l		Got (AST) u/l		ALP u/l	
* Group with Giardiasis	20	3.0	(0.5)	15.6	(3.3)	- 12.6	(1.9)	38.5	(9.1)
* Group with Amoebiasis	15	3.1	(0.5)	15.3	(1.7)	11.7	(0.9)	57.6	(10.9)
* Group with Ascariasis	15	3.3	(0.5)	11.0	(1.5)	10.5	(1.3)	55.9	(19.8)
Total (infected cases)	50	3.3	(0.5)	13.7	(3.0)	11.1	(1.3)	50.9	(14.1)
* Control group	20	4.0	(0.3)	10.0	(1.0)	9.7	(0.9)	95.9	(91.0)
T value			6.0		2.0		2.1		6.0
P level			$p < 0.001$		N.S		N.S		$p < 0.001$

N.S. = Non significant

Table (4) Parasite Type and Corresponding Biochemical Data in Accordance to the Three Categories of the WAZ Score.

Z.score WAZ	Type of parasite	Albumin 9/1	GPT (ALT) u/l	GPT (AST) u/l	ALP u/l
Category I	20 Giardiasis	1.3	14.5	11.7	39.8
- 1.89 (- 0.20)		(0.5)	(0.7)	(1.7)	(10.5)
Category I I	11 Ascariasis	3.6	12.4	11.0	54.2
- 1.37 (- 0.15)		(0.5)	(2.7)	(1.8)	(13.1)
Category I I I	4 Ascariasis	3.7	13.0	11.7	57.8
- 0.76 (- 0.30)	15 Amoebiasis	(0.5)	(2.2)	(1.7)	(11.1)

N.B. WAZ = weight / Age Z - score

Table (5) Parasite Type and Corresponding Biochemical Data in Accordance to the Three Categories of the HAZ Score.

Z-score HAZ	Type of parasite	Albumin g / l	GPT (ALT) u / l	GPT (AST) u / l	ALP u / l
Category I	20 Giardiasis	2.8	15.0	12.1	38.5
- 2.37 (- 0.46)		(0.3)	(0.5)	(2.0)	(8.9)
Category I I	11 Ascariasis	3.9	10.5	10.2	57.5
- 1.31 (- 0.14)		(0.3)	(1.0)	(1.1)	(13.7)
Category I I I	4 Ascariasis	3.8	13.5	11.2	59.6
- 0.49 (- 0.15)	15 Amoebiasis	(0.3)	(2.0)	(1.3)	(8.6)

N.B. WAZ = Height / Age Z - score

Discussion

Parasitic infections and malnutrition are the most common factors which lead to disproportionate body measurements [11]. Crompton and Hall [12] demonstrated a close relationship between the acquisition of intestinal parasites and the impairment of growth.

Anthropometry is the most practical technique for assessment of physical growth, body composition and general nutritional statue [13]. Our anthropometric results revealed significant variations between the means of the infected children and those of the control group, weight per age Z-score and height per age Z-score were significantly reduced in the parasitic group as compared to those of the controls.

These results were in agreement with those of previous studies who reported a high degree of stunting and substantial proportion of wasting in children with parasitic infections [14, 15, 16].

Weight per height square (Body Mass index, BMI) was suggested to be the best weight per height index used for nutritional assessment because it shows the least correlation with height and is recognized as an index of lean body Mass [17]. In our study the mean value of B. M. I. was found to be 14.98 (1.7) in infected children as compared to 17.91 (1.9) in controls, the difference was statistically significant ($t = 6.36$; $p < 0.001$).

These findings could be explained on the basis that parasitic infections cause growth retardation due to malnutrition.

They reduce host nutrient intake and interfere with digestion and absorption of nutrients [18]. Malabsorption of various carbohydrates, fats, proteins as well as vitamins and minerals have been described with a variety of parasitic infections [19].

On comparing the impact of the different types of parasites with the degree of growth impairment, giardiasis associated cases with least Z score for weight/ age and height/ age. Ascariasis and next amebiasis associated cases with higher Z scores respectively (Tables, 4 & 5).

Ascariasis is an infection of the small intestine, and exerts its effect by direct damage of the epithelium, thus resulting in malabsorption and a coeliac like syndrome. It competes with the host on nutrients uptake from the intestine, this resulting in gradual weight loss [20, 21].

As regards ascaris infection, our results simulates the results that were previously shown by Cerf et al., [22], Kan et al., [23], and Gupta et al., [24]. The authors reported that heavy infections with ascaris have been related particularly to stunting and mild - moderate Protein - Energy Malnutrition. The mechanisms by which ascaris could influence growth are likely to be by reducing host nutrient intake, altering metabolism and / or increasing nutrient excretion [25].

GOT and GPT serum levels were determined in this study, to assess the state of liver. The parasites in this study have been reported to cause live damage by several mechanisms [26]. However, results of this study showed that GOT and GPT were within the normal range in both the parasitically infected and the control groups.

Alkaline phosphatase levels obtained in the parasitically infected and the control groups were within reference levels for children. However, mean level of the control group was significantly higher than of the parasitically infected group ($p < 0.001$). A gradual decline in ALP mean level was found, going from cases with high Z-scores (category III) to those with lowest Z scores (category I) for both weight and height per age (Tables 4 & 5).

Besides, a highly significant positive correlation was shown between Z-scores for either weight or height and the ALP levels ($r = 0.55$ and 0.57 respectively).

Similar observation was well shown between Z-score levels and albumin levels in the three categories. These data denote that the worse effect was as well caused by giardiasis where the lowest Z-scores for weight and height, the lowest albumin levels and the lowest ALP levels.

Previous authors have as well described an association of Giardia infection and undernutrition, weight loss, stunting and even growth failure among the infected children [27, 28, 29].

Our results were in agreement with many investigators who reported variable

decrease in serum albumin in children with intestinal parasitic infections. This reduction in the serum albumin level was found to be partly due to malnutrition, which accompanies the majority of parasitic infections; malabsorption as in the cases of Giardiasis **[21]**, and ascariasis **[30]**, blood loss and protein losing enteropathy **[31]**.

A highly positive correlation (r = 0.66) was obtained between the mean level of height / age Z-score (HAZ) and the albumin level in the parasite group ($p < 0.001$), also similar result (r = 0. 45) was obtained between the mean level of weight / age Z-score (WAZ) and the albumin level in same group ($p < 0.001$).

Conclusively, this work demonstrated how the type of parasite is implicated in producing a state of malnutrition. We may as well suggest from this work that alkaline phosphatase could be used as a biochemical indicator in monitoring growth status in children.

References

1. LATNER, A. L.: In: Clinical Biochemistry. ed. by Latner A. L. pp. 555-570. Saunders Co, Philadelphia, London, Toronto, 1975.

2. KAPLAN, M. M., BRENSILVER, H. L.,: Significance of elevated liver alkaline phosphatase in serum, Gastroenterology, 68: 1556, 1975.

3. KOVAR, I. Z. and MAYNE P: Plasma alkaline phosphatase activity in the preterm neonates. Acta Pediatr. Scand., 70: 501, 1981.

4. NELSON, W. E.; BEHRMAN, R.E. and VAUGHAN, V.C.: Parasitic infections. In Nelson Textbook of pediatrics, 13 th edition. W. B., Saunders Company, Philadelphia, London, Toronto, Tokyo, 1978.

5. TANNER, J.M.; MIERNAUX, J.; and JARMAN, S.: Growth and physique studies in Human Biology. A guide to field methods, I. B. P., Hand book, No. 8, Blackwell scientific publications, Oxford and Edinburgh, 1969.

6. MARKELL, E.K.; ASH, L.R. and MELVIN, D.M.: Procedures suggested for use in examination of clinical specimens for parasitic infection. A statement by the subcommittee on laboratory standards, Committee on education, Am. Society of Parasitology, J. Parasitol., 63: 959-960, 1977.

7. NATIONAL CENTER FOR HEALTH STATISTICS (NCHS) GROWTH CURVES FOR CHILDREN : Birth to 18 years. Hyatts Wille, md: US, Department of Health, Education, and Welfare, 1977. (Publication (PHS) 78-1650).

8. FRISANCHO, A. R.: Anthropometric standards for the assessment of growth and nutritional status. Ann Arbor, the University of Michigan Press, 1990.

9. ANTHRO PROGRAM : Version 1.01,1 2 December 1990 Division of Nutrition,

Centers for disease control in Collaboration with the nutrition unit, world Health organization.

10. ARMITAGE, P.: Statistical methods in medical research. Blackwell Scientific Publications, London, 1971.

11. TARDOS, M. B.: Parasitological and nutritional studies on 3000 Egyptian school children in Giza province. J. Egypt. Soc. Parasit., 23:41-56, 1973.

12. CROMPTON, B. W. T.; and HALL, A.: Parasitic infection and Host nutrition. J. Parasitol. 82: 31-38, 1981.

13. HUGHES, J. G.; and GRIFFIT, J. F.: Growth and development for synopsis of pediatrics by Hughes, J. G. and Griffith, J. F. 6th edition. Mosby, p. 732, 1984.

14. KNIGHT, R.: Epidemiology and transmission of Giardiasis. Trans. R. SOC. Trop Med. Hyg., 74: 433-436, 1980.

15. TOMKINS, A. M.: The significance of intestinal parasites in malnourished populations, Parasitology, 82: 31-48, 1981.

16. TANNER, M.; BURNIER, E.; SUTER, R.; et al.: Longitudinal study on the health status of children in a rural Tanzanian Community: Parasitoses and nutrition following control measures against intestinal parasites. Acta Trop. (Basel), 44: 137-174, 1987.

17. CACHERA, R. M. F.; COLE, T. J.; SEMPE, M.; TICHET, J.; ROSSIGNOL, C.; and CHARRAND, A.: Body mass index variations: Percentiles from birth to 87 years. European Journal of clinical Nutrition. (45), 13-21, 1991.

18. EXCLER, J. L.; NICOLUS, E.; et al.: Protein energy malnutrition in Urban African Millieu. Med. Trop., 45 (2): 155-161, 1985.

19. WANKE, C.A.: Infections cause of prolonged diarrhea. Clinical Tropical Medicine and Communicable diseases, 3 (3): 570-585, 1988.

20. STEVENS, D.P.: Giardiasis: Host-pathogen biology. Rev. Infect. Dis. 4: 851, 1982.

21. PANOSIAN, C. B.: Parasitic diarrhea, Emergency Medicine. Clinics of North America, 9 (2): 337-355, 1991.

22. CERF, B. J.; ROHDE, J.E.; and SOESANTO, T.: Ascaris and malnutrition in a Balinese village: a conditional relationship. Tropical and Geographical Med., 33: 367-373, 1981.

23. KAN, S. P., SUBRAMANIAM, K.; and VARGHESE, T.: The effect of ascariasis on weight and height gain among Indian primary school children - a preliminary report. Collected papers on the control of soil-transmitted Helminthiasis II. The Asian Parasite control organization, 309-311, 1983.

24. GUPTA, M. C.: Ascariasis and malnutrition in children: Studies in India and Guatemaa. In Ascariasis and itls public health significance (ed., D> W> T. Crompton). London and Basingstoke: Taylor and Francis Ltd, p. 203-211, 1985.

25. STEPHENSON, L.; MICHAEL, C.; KURZ, K.; et al.: Treatment with a single dose of albendazole improves growth of Ascaris lumbricoides infections. Am. J. Trop. Med. and Hyg., 41 (1): 78-87, 1989.

26. KNIGHT, R.: Local effects of parasitism. In: Parasitic diseases in Man lst ed., by Churchill Livingstone, chap. 7. 115, 1985.

27. SOLOMONS, N. W.: Giardiasis: Nutritional implications. Rev. infect. Dis., 4: 859-869, 1982.

28. STEVENS, D. P.: Selective primary health card: Strategies for control of disease in the developing World. XIX. Giardiasis. Rev. Infect. Dis., 7: 530-532, 1985.

29. DUPONT, H. L.; and SULLIVAN, P. S.: Giardiasis: the clinical spectrum, diagnosis and therapy. Pediatr.. Infect Dis., 5: 131, 1986.

30. TANNER, J. M; and de SAVIGYN, D.: Monitoring of community health status: experience from a case study in Tanzania. Acta trop. (Basel), 44: 261-270, 1978.

31. VARIYAM, E. P.; and BANWELL, J. G.: Hookworm disease: nutritional implications. Rev. Infect. Dis., 4: 830-835, 1982.