Studies on Malabsorption in Malnourished Pakistani Children

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Malnutrition, Lactase Activity

Malnutrition is a common finding in Pakistan especially in children of low socio-economic class. Impairment of digestion and absorption makes the diet inefficient at fulfilling the requirements of the child and leads to malnutrition. Earlier work from this laboratory has shown that feeding a high-protein diet to children suffering from protein-energy malnutrition (PEM) did not improve their condition. In the present study forty-two malnourished children and seventeen control subjects were investigated. They were divided into five groups, *i.e.* fibrocystic disease of the pancreas ($n=9$), coeliac disease ($n=17$), lactose intolerance ($n=5$), PEM ($n=5$) and non-specific diarrhoea ($n=6$) on the basis of history, clinical impression and biochemical findings. They were from 6 months to 12 years of age. The majority of them were suffering from diarrhoea, distension of the abdomen and retardation of growth. All children were physically examined and anthropometric measurements were recorded. Changes in hair in the form of sparseness, dyspigmentation and easy pluckability were observed in all groups. In PEM, 80% of the cases had enlarged livers. All children had reduced weight and height as compared with the control group. Haemoglobin, total protein and serum albumin showed a decrease and the fall was greatest in PEM cases as compared with the control group.

The excretion of α-amino nitrogen increased in PEM children while hydroxyproline and creatinine levels showed a decrease as compared with the control group. The hydroxyproline index, which signifies the growth rate, was also significantly lower in all groups.

Xylose and lactose tolerance tests were performed after an oral dose of xylose or lactose respectively. The xylose concentration after the test dose was reduced with the lowest values in the coeliac disease group as compared with the control group. In the lactose tolerance test, the patients with lactose intolerance showed lower values as compared with control subjects. Sodium and chloride in sweat showed a significant rise in fibrocystic disease while daily faecal fat excretion was increased in fibrocystic disease, coeliac disease and lactose intolerance cases as compared with the control group. The various biochemical indicies studied indicate that malabsorption played an important role in malnourishment.

Introduction

Insufficient diet alone is not the cause of malnutrition but other conditions like coeliac disease, fibrocystic disease of pancreas, lactose intolerance, milk protein allergy, all cause different degrees of malnutrition. In Pakistan, protein-energy malnutrition (PEM) is common and marasmus is four times commoner than kwashiorkor [1]. A high protein diet fed to malnourished children failed to improve their condition [2, 3].

In areas of the world where malnutrition is prevalent, infantile diarrhoea presents a major problem. Digestion and absorption play a major part in the causation of diarrhoea. Pancreas becomes atrophic with reduction in pancreatic enzymes. Malabsorption makes diet inefficient to fulfil the requirements of the child. Cystic fibrosis causes the deficiency of lipase resulting in massive streatorrhoea, energy loss in feces and changes in electrolyte composition of sweat. In coeliac disease, malabsorption occurs due to a decreased area of absorption and impaired enzyme activity. Lactase activity is diminished or absent in most of the children suffering from PEM. The present study describes the investigation on the role of malabsorption in malnutrition in children.

Materials and Methods

A total of 42 children between 6 months to 12 years of age, suffering from malnutrition were indoor patients of Pediatric Departments of Jinnah Postgraduate Medical Centre and Civil Hospital, Karachi. At the time of admission their general and dietary histories, physical examination for deficiency diseases and anthropometric data were recorded on a proforma. The children were divided into fibrocystic disease of pancreas, coeliac disease, lactose intoler-

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ance, PEM and non-specific diarrhoea on the basis of clinical impression.

Seventeen apparently healthy children matched for age and socio-economic status were also studied as control. Weight (kg) and height (cm) were recorded and weight for height percentage was calculated [4].

Collection of specimen

Stool: Two small size butter cakes (about 2 oz.), one in the morning and one in the evening, in addition to routine hospital diet, was given to the child daily. This routine was started 2–3 days prior to and throughout the collection. The sample of stool was collected for three days in a preweighed container with a tight fitting cover. After the entire collection the container was weighed and the contents were mixed by a glass rod and homogeneous mixture was made sometimes with the addition of water. The sample was preserved at −20 °C till analyzed.

Urine: A 24 h specimen was collected and stored in a refrigerator.

Sweat: Before collection of sweat sample, the face and the hands of the child were thoroughly washed with distilled deionized water and was dried with the help of a forcep. In summer collection of sweat was not a problem but in winter sweating had to be induced by the help of a heater. The heater was placed in a small cubical and when the atmosphere was quite hot, the child was kept in the cubical till the sweating was induced. The sweat was soaked on a preweighed filter paper (Whatman 41) and kept in a covered petri dish. The weight of sweat was determined and it was assumed that specific gravity of sweat was 1. Deionized water was added to filter paper to prepare 1:100 dilution and recovered by squeezing. The contents were centrifuged and preserved for analysis.

Blood: Child was fasted from midnight and blood was drawn at about 8.00 a.m. next morning. Blood was collected in two tubes, one of which contained antiçoagulant (patassium oxalate and sodium fluoride, 3:1).

Xylose absorption test was done on the patient who was fasted (8 h) by feeding 5 g xylose dissolved in 200 ml water. Blood samples were obtained in fasting state and 60 and 120 min after the test dose.

Lactose tolerance test was done on the child who was fasted from midnight and 2 ml blood was drawn at about 8.00 a.m. Then 2 g of lactose per kg body weight was given orally in about 200 ml of water. Blood samples were collected at 1 and 2 h interval after the test dose.

Hydroxy proline index was the product of body weight (kg) and the ratio of urinary hydroxy proline and creatinine (mg/dl).

Analytical procedures

Hemoglobin was determined by cyanmethemoglobin method and serum protein by Reinhold method [5], xylose by ortho-toluidine method [6], alpha-amino nitrogen in urine by ninhydrin method [7], hydroxy proline in urine by the method of Blomfield and Farrar [8], urinary creatinine by alkaline picrate method [9], total fat in feces by the method of Van de Kamer *et al.* [6], sweat sodium by flame photometry and chloride by the method of Schales and Schales [6]. The rise in blood glucose level after the test dose of lactose was determined by Nelson-Somogyi method [6].

Results

The children suffering from PEM were under 3 years of age and lactose intolerance cases were youngest of all (Table I). High incidence of past history of illness was observed in each group. Fibrocystic, coeliac and PEM cases gave 100% history of past illness while lactose intolerance and non-specific diarrhoea cases showed 80 and 83% respectively. Diarrhoea and distension of abdomen were the most common symptoms in all 5 groups of patients. Four deficiency cases presented with signs of vitamin A deficiency, 11 with vitamin B complex deficiency while vitamin C deficiency was not found in any case.

Physical examination revealed a frequent finding of changes in hair in the form of sparseness, dyspigmentation and easily pluckability in all groups. In PEM 80% cases had enlarged liver. The patients came from different parts of the country and belonged to low socio-economic class.

When children were assessed for nutritional deficiencies on the basis of weight and height, it was observed that children had significantly reduced weight and height as compared with control group (Table I). Fibrocystic and coeliac disease cases belonged to first degree malnutrition (weight for height was 90–80%). PEM cases also showed weight for height between 90–80% but was due to edema. Lactose intolerance and non-specific diarrhoea cases

Table I. Physical features, blood and urine analytes, xylose and lactose tolerance tests, fecal fat and sweat electrolytes in control and malnourished children. The values are mean ± s.e.m.

	Control	Fibrocystic dis. of pancreas	Coeliac	Lactose intolerance	PEM	Non-specific diarrhoea
Physical features:						
Total number of cases	17	9	17	5	5	6
Age (months)	73.6 ± 10.3	67.4 ± 11.3	89.1 ± 7.5	14.4* ± 5.6	31.2* ± 2.3	43.0* ±11.4
Sex (males)	7	4	8	2	2	3
Weight [kg]	18.4 ± 2.0	9.7 ± 1.3	19.5 ± 6.5	4.9 ± 1.1	7.2 ± 0.4	5.4 ± 1.4
Height [cm]	107.9 ± 6.6	82.4 ± 6.4	95.3 ± 5.1	52.6 ± 7.6	67.8 ± 2.6	59.4 ± 4.3
Weight for height [%]	95.8 ± 0.8	79.3* ± 2.3	79.0* ± 2.6	63.2* ± 8.2	75.2* ± 1.5	54.5* ± 5.6
Blood:						
Hemoglobin [g/dl]	12.4 ± 0.3	8.6* ± 0.5	7.7* ± 0.4	8.3* ± 0.7	6.3* ± 0.5	8.2* ± 0.6
Total serum protein [g/dl]	7.2 ± 0.2	5.6* ± 0.3	6.3* ± 0.2	5.3* ± 0.6	4.5* ± 0.3	5.7* ± 0.7
Albumin [g/dl]	4.3 ± 0.1	2.8* ± 0.2	3.3* ± 0.2	2.4* ± 0.4	1.6* ± 0.2	3.0* ± 0.4
Albumin/Globulin ratio	1.4 ± 0.05	1.1 ± 0.2	1.3 ± 0.2	0.8* ± 0.1	0.5* ± 0.05	1.1 ± 0.08
Urine:						
Alpha amino nitrogen [mg/dl]	7.8 ± 0.3	8.5 ± 0.3	8.6 ± 0.3	7.3 ± 0.6	15.4* ± 0.8	8.1 ± 0.8
Hydroxy proline [mg/dl]	7.9 ± 0.3	2.8* ± 0.2	2.5* ± 0.1	3.2* ± 0.4	2.6* ± 0.2	3.1* ± 0.4
Creatinine [mg/dl]	55.1 ± 2.3	25.3* ± 1.0	28.6* ± 0.7	23.2* ± 1.6	25.0* ± 1.3	21.8* ± 1.4
Hydroxy proline index	2.5 ± 0.2	1.0* ± 0.08	1.3* ± 0.09	0.6* ± 0.05	0.8* ± 0.04	0.6* ± 0.1
Xylose tolerance test:						
1 h [mg/dl]	51.9 ± 1.6	54.6 ± 1.5	16.8* ± 1.0	–	45.2* ± 3.2	36.0* ± 5.5
2 h [mg/dl]	36.8 ± 1.7	49.7 ± 1.2	14.3* ± 1.0	–	40.8 ± 2.4	29.0 ± 6.6
Lactose tolerance test:						
0 h [mg/dl]	84.8 ± 3.0	–	–	66.8* ± 2.9	–	–
1 h [mg/dl]	113.8 ± 4.0	–	–	71.8* ± 2.4	–	–
2 h [mg/dl]	98.6 ± 2.7	–	–	69.2* ± 2.7	–	–
Feces:						
Fat [g/day]	2.0 ± 0.2	14.3* ± 0.8	9.3* ± 0.3	3.1* ± 0.4	2.2 ± 0.2	2.4 ± 0.6
Sweat:						
Sodium [mEq/l]	40.5 ± 1.6	146.0* ± 4.9	41.0 ± 2.2	36.9 ± 2.7	36.6 ± 2.6	36.1 ± 1.8
Chloride [mEq/l]	34.5 ± 1.2	140.1* ± 3.4	36.6 ± 1.1	31.2 ± 2.4	36.3 ± 2.4	36.0 ± 1.5

* $P < 0.05$ as compared with control group.

showed third degree of malnutrition *i.e.*, values of weight for height were less than 70%.

Hemoglobin, serum protein and albumin were decreased in all groups of patients as compared with control subjects (Table I). Albumin:globulin ratio was particularly low in PEM cases. Alpha-amino nitrogen in urine was increased in PEM patients while hydroxy proline, creatinine and hydroxy proline index decreased significantly as compared with control group. The xylose tolerance test showed a significant fall in coeliac disease, PEM and non-specific diarrhoea patients after one hour of xylose load orally. The mean values of lactose tolerance test showed a significantly low in lactose intolerant group at 0,1, or 2 h of lactose dose.

Daily fecal fat excretion showed an increase in fibrocystic disease of pancreas, coeliac disease and lactose intolerance cases (Table I). Sweat electrolytes were increased in fibrocystic disease patients only as compared with control group.

Discussion

Malnutrition is a common finding in Pakistan particularly in children. In big cities like Karachi where conditions of living are better, still large number of children attend the hospitals with malnutrition and are suffering from diarrhoea, distension of abdomen and retardation of growth. From these observations, it was assumed that malabsorption of nutrients, rather than defective poor diet, may be contributing to the malnutrition in these children.

Malnourished children were divided into five groups. Age distribution of various groups showed no significant difference between groups except that of PEM group who were under 3 years and lactose intolerance cases who were younger than other groups (Table I). All the cases were from low socioeconomic class and the largest number of them were from Karachi and their per capita income was more than those from North West Frontier Province with lowest incidence and their per capita income was also the lowest in all groups. This indicates that the main cause of malnutrition was not the non-availability of food. Gopalan and Rao [10] reported that they could not find any difference in the diet of malnourished children. In one family some children develop malnutrition while others do not.

Earlier work from this laboratory [2, 3] have shown that feeding a high protein diet to children with PEM did not improve their condition. The resistance to improvement and the cause of PEM were attributed to either some congenital deficiency perhaps due to malnutrition of the mother or prematurity at birth. In the present study the incidence of prematurity was not high and only in lactose intolerance and PEM cases there was 20% incidence of prematurity.

Majority of patients presented with a history of diarrhoea and distension of abdomen. Frequency of respiratory infection (cough), anemia (pale conjunctiva) and edema in PEM cases was high. Signs and symptoms related to vitamin deficiencies were found to be low. Vitamin A deficiency was observed in fibrocystic and in coeliac disease (due to poor absorption of fat) and vitamin B complex deficiencies in lactose intolerance, PEM and non-specific diarrhoea cases (due to malabsorption of vitamins).

When children were assessed for nutritional deficiencies on the basis of anthropometric data, all the diseased children had significantly reduced body measurements as compared with normal children. Waterlow [11] applied the loss of weight in relation to height as the basis for quantitative classification of malnutrition as 1st., 2nd., and 3rd. degree of wasting. In the present study all the children were suffering from varying degrees of growth retardation.

Anemia was present in all cases. A number of authors also reported anemia in malnutrition [12], which was attributed to poor absorption of iron [13]. The decrease in serum proteins (Table I) was probably due to decreased rate of synthesis or due to increased plasma volume [14] particularly in fibrocystic disease. All malnourished children had decreased creatinine and hydroxy proline excretion, suggesting the poor body protein reserve. A significant correlation was found between hydroxy proline index and the nutritional status of the children (Table I).

Xylose tolerance test indicates the defect of carbohydrate absorption from upper intestine and all malnourished children except fibrocystic disease cases, showed a decrease in xylose concentration as compared with control group (Table I). The results are in conformity with those of Buts *et al.* [15]. Sweat sodium and chloride were elevated in fibrocystic disease of pancreas (Table I) and although it does not indicate any absorptive defect of intestine, it differentiates fibrocystic disease from other conditions of malabsorption. Similarly fecal fat excretion was in-

creased in fibrocystic disease, coeliac disease and lactose intolerance cases (Table I). Riley and Glickman [16] have shown that severe protein energy malnutrition and coeliac disease cause destruction of mucus membrane of intestine and this impaired apoprotein synthesis which is a contributary factor in the resultant fat malabsorption and steatorrhoea. It appears that all children suffering from malnutrition belonging to any group showed a defective absorption of the nutrients.

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[1] R. J. Rahimtoola, J. Pakistan Med. Asso. **20,** 192 (1970).
[2] M. A. Kader and M. A. Rahman, Brit. J. Nutr. **28,** 191–200 (1972).
[3] S. T. Shoukat, S. Hujjatullah, M. A. Rahman, and R. Rahimtoola, J. Res. Lab. Med. **6,** 65–72 (1979).
[4] F. H. Harvie, Pediatric methods and standards. 4th Ed. Lea and Febiger, p. 18, Philadelphia 1962.
[5] H. Varley, A. H. Gowenlock, and M. Bell, Practical Clinical Biochemistry, Vol. 1, General Topics and Commoner Tests. 5th Ed. William Heinemann Medical Books Ltd., p. 979–980, London 1980.
[6] J. D. Bauer, P. G. Ackermann, and G. Toro, Clinical Laboratory Methods. 8th Ed. Mosby, St. Louis, p. 383–384, 393, 536 and 543 (1974).
[7] A. Khachadurian, W. E. Knox, and A. M. Cullen, J. Lab. Clin. Med. **56,** 321–332 (1960).
[8] J. Blomfield and J. F. Farrar, Anal. Chem. **36,** 950–952 (1964).
[9] N. W. Tietz (ed.), Fundamentals of Clinical Chemistry. 2nd Ed. Saunders, p. 995–998, Philadelphia 1976.
[10] C. Gopalan and B. S. N. Rao, Indian J. Med. Res. **59** (suppl), 143 (1971).
[11] J. C. Waterlow, Br. Med. J. **iii,** 566 (1972).
[12] P. Fondu, C. Hariga-Muller, N. Mozes, J. Neve, A. van Steirteghem, and I. M. Mandelbaum, Am. J. Clin. Nutr. **31,** 46–56 (1978).
[13] J. B. Massa, V. S. Peterson, and R. M. Robbin, Am. J. Clin. Nutr. **31,** 76 (1978).
[14] W. Strober, G. Peter, and R. H. Schwartz, Pediatrics **43,** 416–426 (1969).
[15] J. P. Buts, C. L. Morin, C. C. Roy, A. Weber, and A. Bonin, J. Pediatr. **92,** 729–733 (1978).
[16] J. W. Riley and R. M. Glickman, Am. J. Med. **67,** 980–988 (1979).