Serum Enzyme Levels In Protein-Calorie Malnutrition

Studies in Children With Kwashiorkor and Marasmus

Enzymatic changes occur in response to alterations in nutritional status. In animals maintained on protein-deficient diets many tissue enzyme levels are lowered. This subject has been extensively reviewed by Knox, Auerbach, and Lin. In children suffering from kwashiorkor—a syndrome of protein-calorie malnutrition—not only have the duodenal enzymes been shown to be low, but some of the blood enzyme concentrations are also reduced. These observations are generally in keeping with the finding that in kwashiorkor most tissues show evidence of structural damage, the liver and pancreas being particularly affected.

Studies on serum enzyme levels in marasmus, another form of protein-calorie malnutrition, are, however, lacking. The extreme degree of fatty infiltration of the liver which is an invariable and characteristic feature of kwashiorkor is rarely seen in marasmus. Studies on certain serum enzyme levels in marasmus may be expected to indicate the functional status of the liver and pancreas and to reveal differences, if any, in this respect between children suffering from kwashiorkor and those suffering from marasmus.

Serum protein levels, serum esterase, lipase, amylase, and urea concentrations in both marasmic and kwashiorkor children have been determined at the height of the disease and the effects thereon of nutritional rehabilitation investigated.

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S. G. Srikanth, MBBS, Nutrition Research Laboratories, Indian Council of Medical Research, Tarnaka, Hyderabad 7 (Dn), India.
Nutrition Research Laboratories, Indian Council of Medical Research.
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Material and Methods

Twenty-eight children suffering from kwashiorkor and 18 children suffering from marasmus admitted as inpatients formed the subjects for study. The ages of the marasmic children ranged between 7 and 36 months, while that of children with kwashiorkor ranged from 18 to 60 months. Edema, moon-face, apathy, retarded growth as evidenced by gross underweight, associated skin and hair changes, hypoproteinemia, and a history of having subsisted on an inadequate dietary intake prior to the onset of the disease were diagnostic features of kwashiorkor.

Easily differentiated clinically from such children were the subjects suffering from marasmus. The complete absence of edema, in the presence of a loss of subcutaneous depot fat, severe wasting of muscles, and gross underweight characterized the latter clinical picture. Changes in the skin and hair of the type associated with kwashiorkor were strikingly absent. The principal diagnostic differences between the two conditions lay in the absence of edema and the presence of marked tissue wasting in the marasmic children.

Results of oral questionnaire dietary surveys indicated that while dietary protein and calorie intake were inadequate in both groups of children, the protein deficiency was relatively greater in the children with kwashiorkor, while the calorie deficiency was more marked in the marasmic children. The marasmic children studied here can be considered to represent cases of primary dietary inadequacy, since children with chronic infections were excluded from the investigation.

A sample of blood was drawn under basal conditions for the determination of total serum protein, albumin, serum esterase, amylase, and lipase, and serum urea concentration. All the children then were rehabilitated with a daily diet providing 1,000-1,200 calories and 50 gm protein, 40 gm of which was derived from skim milk. Repeat samples of blood for the biochemical determinations were drawn on the 10th and 30th days of therapy.

Total proteins and albumin in serum were determined by the micro-Kjeldahl technique by estimating the total N and using 6.25 as the multiplication factor. A solution of 28% sodium sulphite was used to fractionate albumin.

Serum esterase was determined by the method of Cherry and Crandal,6 serum lipase by the method of Goldstein, Epstein, and Roe* as modified by Srinivasan and Patwardhan,10 and serum amylase by the method of Gomori.11 Serum urea was determined by the aeration method of van Slyke and Cullen.12

Results and Comment

The results (Table) indicated that serum albumin levels in all the children studied were generally lower than in normals. The levels in children with kwashiorkor, however, were lower than those in marasmic children. Similarly, the serum esterase, though lower than normal in both groups, was more markedly reduced in children with kwashiorkor. Serum lipase levels were almost normal in marasmic children but considerably reduced in the kwashiorkor group. Like the other two enzymes, serum amylase levels also were reduced to a greater extent in children with kwashiorkor than in those with marasmus. In four children with kwashiorkor no amylase activity could be detected in the serum, and in six others, the activity was less than 25 units/10 ml. On the other hand, all the marasmic children except one had values of 50 units/10 ml or more. Most marasmic children had serum urea levels which could be considered normal, only three having values below 18 mg/100 ml, while 15 out of 18 children with kwashiorkor had values less than 15 mg/100 ml. After treatment the serum lipase levels had returned to almost normal in both groups, while the esterase levels, though tending to rise, were still below normal concentration. Serum urea had increased in every case at the end of 30 days' therapy. Serum amylase levels not only had returned to normal in all subjects but in several children with kwashiorkor had continued to rise to levels much higher than the upper limits of the normal range.

Enzymes are specific proteins, and since there is evidence that many of them are synthesized at specific sites, changes in serum enzyme concentrations might be taken to reflect changes in the corresponding tissues. Serum lipase and amylase levels on this basis could be taken to indicate the functional status of the pancreas, while serum esterase may reflect the activity of the liver. The very low levels of both lipase and esterase in children with kwashiorkor would then suggest functional damage of both the pancreas and the liver. Indeed, structural damage to both these organs is a characteristic feature of the disease. The presence of almost normal levels of serum lipase in marasmic infants may, by the same token, be taken to represent a func-
tionally adequate pancreas. The finding that serum amylase levels were also considerably higher in these children would support such a concept. Although the salivary glands also secrete amylase, it has been established that salivary amylase has little influence on serum amylase levels. The amylase activity in serum represents the pancreatic amylase. The much higher levels of serum esterase in marasmic subjects, as compared to the cases of kwashiorkor, would also indicate that liver function is probably better maintained in the former disorder. Liver biopsy studies, carried out on ten marasmic children, revealed that in only three was there evidence of a mild degree of fatty infiltration. Some of the biopsies showed cytoplasmic vacuolation of the type commonly seen in protein-deficient states.

The increase in the concentration of all three enzymes determined after treatment is similar to that reported in earlier studies and may be interpreted as evidence of functional recovery of the secretory organs concerned. The observation that serum amylase increased to greater than normal levels in several children with kwashiorkor is, however, unusual and requires explanation. As part of a study designed to assess the effects of dietary fat in the treatment of kwashiorkor, some of the children investigated here had received butter fat to provide nearly 40% of the calorie intake. It is significant that it was only among these children that the amylase activity had risen to unusually high levels. That this rise may be a specific response to the fat level in the diet is suggested by the observations of Wiberg and Tuba, who found that diets high in fat significantly raised the serum amylase activity in rats. The mechanism of such action, however, is not clear.

A direct correlation between serum albumin levels and the enzyme levels at the time of admission could not be obtained. It may be of significance, however, that among the marasmic subjects three had serum lipase levels which were obviously low. These three children also had low serum albumin concentrations ranging from 2.2 to 2.6 gm/100 ml as compared to the mean value of 3.2 gm/100 ml for the marasmic children as a whole.

Summary

Levels of serum proteins, serum esterase, lipase, and amylase, and serum urea were determined in groups of children suffering from kwashiorkor and marasmus, at the time of admission and after four weeks of nutritional rehabilitation.

The concentrations of all the constituents studied were lowered to a greater extent in children with kwashiorkor than in marasmic subjects. Serum lipase and urea levels did not appear to be lowered in marasmic children.

Nutritional rehabilitation brought about an increase in the concentrations of both the protein and the enzyme levels.

The differences in enzyme levels between kwashiorkor and marasmus suggest that the hepatic and pancreatic functions are relatively better maintained in the latter disorder.
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Dr. C. Gopalan, MD, PhD (Lond), Director, Nutrition Research Laboratories, Hyderabad, aided in the course of this study.

REFERENCES