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THE EFFECT OF DIETS CONTAINING MILK FAT AND SUNFLOWER-SEED OIL ON THE LEVELS OF CERTAIN CONSTITUENTS IN THE BLOOD SERUM OF KWASHIORKOR PATIENTS

H. S. MEY, M.Sc., *Department of Physiology, University of Pretoria,* AND P. J. PRETORIUS, M.D., *National Nutrition Research Institute, CSIR, and Department of Paediatrics, University of Pretoria*

Biochemical changes in the serum constituents of kwashiorkor patients have been studied extensively in recent years. In most of these investigations patients have been treated with skimmed-milk diets, since it is generally believed that these patients tolerate fat poorly, and that the severity of the diarrhoea that is almost invariably present is increased when fat is included in the diet.

Kahn[1] introduced diets of half-cream milk in the treatment of kwashiorkor patients and no ill-effects were encountered. Dean and Weinbren[2] found soya and cottonseed oil to be well tolerated. Gómez *et al.*[3] regard the long-established practice of decreasing the intake of fat in severe malnutrition in infants as unnecessary and even undesirable.

Various serum constituents have been determined in order to assess the response of kwashiorkor patients to treatment; for this purpose the albumin and cholesterol levels and the amylase activity have apparently been deemed the most useful.[4-6] Matthew and Dean[7] reported on the relationship between diet and serum cholesterol concentration in kwashiorkor patients during treatment, while Mey *et al.*[8] studied the effects of diets containing different types of fat and protein on the levels of several constituents (including various lipid fractions) in the serum of convalescent patients.

The present report describes biochemical changes that occurred in the serum of patients with acute kwashiorkor when receiving isocaloric milk diets that differed in type and amount of fat. Observations on the clinical progress, diarrhoea, and nitrogen, fat and mineral balances of the patients, have already been reported.[9]

SUBJECTS AND METHODS

The present investigations were carried out on 90 Bantu infants with kwashiorkor, admitted to the Pretoria General Hospital. The patients were divided at random into 3 groups of 30. On the day following admission patients were placed on one of the following diets: (*a*) dried whole milk, (*b*) skimmed milk with added sunflower-seed oil, and (*c*) skimmed milk with added carbohydrate. Each diet provided (per kg. body weight per day) about 4 G of protein and 75 calories. The number of calories derived from fat was equal in the first two diets (36 per kg. body weight per day). In the diet of the third group, which received virtually no fat, the total caloric content was adjusted to the required level by the addition of dextrin-maltose.

Blood was taken from each child on the day following admission and thereafter at weekly intervals for 3 weeks. The following determinations were carried out: serum proteins,[10] cholesterol,[11] phospholipid[12] and total lipid;[13] and serum-amylase activity was determined according to the method of Smith and Roe[14] with modifications as suggested by Fishman and Doubilet.[15]

The 3 sets of results were analysed statistically in conjunction with the results of a fourth trial conducted under similar conditions and designed to test the effect of acidified whole milk on kwashiorkor patients. For the purpose of the present report the results obtained with the latter diet, which were not significantly different from the results of the whole-milk group, are not given separate consideration. The different groups of patients were compared by means of the Kruskal-Wallis one-way analysis of variance.[16] In cases where a significant difference was found, all combinations of pairs taken from the groups were further compared by means of the U-test of Wilcoxon, Mann and Whitney.[16] In all the statistical tests a probability level (two-tailed) of 1% was regarded as significant. These tests were applied to the initial biochemical values obtained in the different groups and then to the changes in the levels after 1 week, 2 weeks and 3 weeks of treatment. The differences between the first and the third weeks were also compared.

RESULTS

The results obtained are set out in Tables I-VI. No statistically significant differences could be detected between the three groups at any stage during the course of the experiment in the levels of serum protein, albumin, amylase activity, and total lipids.

The initial cholesterol values were not significantly different in the 3 groups, but the changes from the initial values to those obtained after 1 week differed significantly in the whole-milk group (average increase=82 mg./100 ml.) from those in the skimmed-milk group (average increase=

TABLE I. MEANS AND RANGES OF CHANGES IN SERUM-ALBUMIN CONCENTRATION DURING TREATMENT

Diet	*Day following admission*	*First week*	*Second week*	*Third week*
Dried whole milk	1·9 (1·1—2·6)	2·6 (1·6—3·6)	3·5 (2·7—4·6)	3·8 (3·0—4·6)
Dried skimmed milk + sunflower-seed oil	1·9 (1·2—2·9)	2·6 (1·6—3·6)	3·5 (2·1—4·7)	3·8 (3·0—5·2)
Dried skimmed milk + carbohydrate	1·9 (1·1—3·0)	2·8 (1·3—4·3)	3·5 (2·6—4·7)	3·5 (2·2—4·2)

TABLE II. MEANS AND RANGES OF CHANGES IN SERUM-GLOBULIN CONCENTRATION DURING TREATMENT

Diet	*Day following admission*	*First week*	*Second week*	*Third week*
Dried whole milk	2·5 (1·9—3·4)	3·3 (1·9—4·5)	3·6 (2·0—5·1)	3·8 (2·5—5·4)
Dried skimmed milk + sunflower-seed oil	2·4 (1·6—3·0)	3·4 (2·4—6·5)	3·7 (2·7—5·1)	3·7 (2·9—5·8)
Dried skimmed milk + carbohydrate	2·4 (1·9—3·5)	3·5 (2·0—4·8)	3·6 (2·6—5·1)	3·9 (2·8—5·4)

TABLE III. MEANS AND RANGES OF CHANGES IN SERUM-AMYLASE ACTIVITY DURING TREATMENT

Diet	Day following admission	First week	Second week	Third week
Dried whole milk	59 (28—117)	83 (45—136)	81 (35—142)	82 (40—136)
Dried skimmed milk + sunflower-seed oil	53 (29—125)	104 (32—167)	92 (31—167)	90 (49—181)
Dried skimmed milk + carbohydrate	61 (25—167)	114 (47—197)	109 (40—175)	109 (47—167)

TABLE IV. MEANS AND RANGES OF CHANGES IN TOTAL SERUM-LIPID LEVELS DURING TREATMENT

Diet	Day following admission	First week	Second week	Third week
Dried whole milk	520 (300—812)	804 (575—1,250)	824 (325—1,200)	711 (500—900)
Dried skimmed milk + sunflower-seed oil	483 (338—938)	846 (425—1,075)	773 (450—1,075)	654 (475—962)
Dried skimmed milk + carbohydrate	484 (350—800)	934 (600—1,412)	830 (600—1,038)	702 (475—963)

TABLE V. MEANS AND RANGES OF CHANGES IN TOTAL SERUM CHOLESTEROL LEVELS DURING TREATMENT

Diet	Day following admission	First week	Second week	Third week
Dried whole milk	113 (68—195)	195 (118—273)	208 (104—300)	185 (98—307)
Dried skimmed milk + sunflower-seed oil	99 (57—178)	211 (100—359)	205 (67—366)	157 (92—239)
Dried skimmed milk + carbohydrate	100 (51—188)	250 (118—412)	232 (145—347)	200 (102—284)

TABLE VI. MEANS AND RANGES OF CHANGES IN SERUM PHOSPHOLIPID LEVELS DURING TREATMENT

Diet	Day following admission	First week	Second week	Third week
Dried whole milk	192 (104—432)	224 (158—357)	223 (133—347)	201 (154—266)
Dried skimmed milk + sunflower-seed oil	185 (110—311)	243 (166—401)	211 (126—326)	172 (136—258)
Dried skimmed milk + carbohydrate	176 (95—360)	269 (141—400)	239 (168—322)	211 (138—272)

150 mg./100ml.). Significant differences were also found in the decreases that occurred from the first to the third weeks between the whole-milk group (average decrease = 10 mg./100ml.) and the skimmed milk and sunflower-seed oil group (average decrease = 53 mg./100ml.). The remaining differences in the cholesterol levels were not significant.

As with serum cholesterol, the initial levels of phospholipid were not significantly different in the 3 groups, but the changes from the initial levels to those of the first week were significantly different in the whole-milk group (average increase = 32 mg./100ml.) from those in the dried skimmed-milk group (average increase = 93 mg./100ml.). The changes from the first to the third week differed significantly in the whole-milk group (average decrease = 23 mg./100ml.) from those in either the skimmed-milk group (average decrease = 58 mg./100ml.) or the skimmed milk and sunflower-seed oil group (average decrease = 71 mg./100ml.).

DISCUSSION

The addition of milk fat or of sunflower-seed oil to the skimmed-milk diet, widely used in the treatment of kwashiorkor, appeared to have no adverse effects as judged by the changes in the serum constituents observed during recovery.

The levels of serum albumin and globulin rose equally rapidly in all 3 groups during treatment, the main increase occurring during the first 2 weeks (Tables I and II). No evidence, therefore, was obtained that the addition of milk fat or sunflower-seed oil to a skimmed-milk diet enhances the regeneration of serum proteins in the acute stage of kwashiorkor.

The low initial values for serum-amylase activity, and the subsequent rise that occurred during successful treatment, are in agreement with the results obtained by other workers.[17,18] In the present study the amylase activity in all 3 groups increased considerably during the first week of treatment and then declined to a slightly lower level during the subsequent 2 weeks (Table III).

Reports[6,17-20] that serum-lipid levels are low in acute kwashiorkor but rapidly reach 'normal' levels during treatment after rising to a transient peak are confirmed by the results of the present study (Tables IV-VI). In most instances the peak values were reached after the end of the first week. Matthew and Dean[7] have suggested that the early increase in serum lipids may be due to the release of accumulated lipid held in the liver, the later fall being dependent on the formation of the lipid-protein complexes needed for lipid transport. It was also pointed out by these authors that the successful treatment of kwashiorkor results in a brisk renewal of anabolic activity of all kinds, including the synthesis of new cholesterol. According to Schendel and Hansen[6] an arrested rise or a fall in serum cholesterol during the early stages of treatment coincides with the onset of complications or is indicative of inadequate treatment, a finding not confirmed by Matthew and Dean.[7] In the present series all but one of 5 fatal cases on whom cholesterol estimations were repeated after 1 week showed a substantial rise in serum cholesterol (average increase = 75 mg./100ml.). An increase in this constituent is therefore not necessarily a favourable prognostic finding.

If it is assumed that the initial increase of serum lipids is due to their release from the liver, the more rapid rise in serum cholesterol and phospholipid on the part of the skimmed-milk group may indicate that their diet was more effective than whole milk in removing lipid from the liver. In Dean and Matthews' series[7] the average increase in cholesterol concentration was higher on a diet containing butterfat than on a fat-free diet, but the fat intake in their patients was higher (5·3 G/kg./day) than in our patients in the whole-milk group (intake about 4 G/kg./day).

The significant differences in the changes from the first to the third week observed in the serum cholesterol and phospholipid levels between the different therapeutic groups may have been due to differences in the type and amount of fat present in the 3 diets, since vegetable oils are known to have a lowering effect on serum cholesterol concentration because of their high unsaturated fatty-acid content. These differences did not, however, reflect the superiority of a specific diet in initiating cure, since mortality rate, clinical response and nitrogen balance were not significantly different in the 3 therapeutic groups.[9]

SUMMARY

An investigation is described of the effect of dried whole milk, dried skimmed milk with added sunflower-seed oil, and dried skimmed milk with added carbohydrate, on the serum protein and lipid and serum-amylase activity of 90 kwashiorkor patients over an experimental period of 3 weeks.

At no stage during the course of the experiment could significant differences at a 1% level be detected among the 3 groups in the changes that occurred in the serum-protein

level, serum-amylase activity, and total serum lipids. Although some of the changes in the serum cholesterol and phospholipid levels were significantly different in the 3 therapeutic groups during certain periods of the experimental periods, no significant differences were detected in these at the end of the experiment.

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