JEJUNAL DISACCHARIDASES IN PROTEIN ENERGY MALNUTRITION AND RECOVERY

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ABSTRACT

The jejunal disaccharidases, sucrose, maltose and lactose, were determined in jejunal biopsies obtained from 43 malnourished children and 10 controls. In the study group, 63% were girls and 93% had severe malnutrition. Lactase activity was significantly reduced in third and fourth degree malnutrition ($p < 0.05$ and $p < 0.005$, respectively), but maltose activity was significantly reduced only in the fourth degree malnutrition ($p < 0.01$). After recovery, maltose and sucrose activities showed a marginally significant increase ($p = 0.06$), where lactase showed no significant increase ($p > 0.05$). We conclude that jejunal disaccharidase activity decreases significantly with increasing severity of malnutrition, lactase being the most severely affected and the last to recover.

Key words: *Protein energy malnutrition, Disaccharidase activity, Maltose, Sucrose, Lactase.*

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Diarrhea is described as an almost constant association of the clinical picture of protein energy malnutrition(l). This has prompted the investigation of disturbances of structure and function of the gastrointestinal tract in malnutrition. Since carbohydrates constitute 50-70% of dietary intake, a study was undertaken to determine the effect of malnutrition on the jejunal disaccharidases and their status on nutritional recovery.

Material and Methods

The study was done in a pediatric ward of a Municipal Hospital. Children suffering from protein energy malnutrition admitted to the pediatric ward over a period of two years were included in study. There were fifteen boys and twenty-eight girls between the ages of*three months to ten years. All patients came from the lower, socioeconomic class and lived in poor hygienic conditions. None of the patients had primary diseases of the liver, pancreas or the biliary tract, malabsorption due to congenital deficiency of the brush border enzymes or chronic organ failure.

The patients were classified according to the Jellife's modification of Gomez classification(2). They were subjected to a complete hemogram, serum protein and serum albumin estimation, urine and stool analysis and culture, Mantoux test and X-rays. After ruling out bleeding diathesis, a peroral jejunal biopsy was performed by a modified Watson's capsule(3). The method of jejunal biopsy was modified for pediatric use and the time duration of the procedure was effectively reduced to between 5 and 30 minutes without any complications. The position of the biopsy capsule was checked by X-ray with image intensification and biopsies were taken from the jejunum within

5 cm of the duodeno-jejunal flexure. The biopsy was stored in a small sealed container in dry ice until disaccharidase activity was measured within 24 hours of the biopsy. Estimation of the brush border maltase, sucrase and lactase was done by the modified Dahlqvist's technique(4,5).

Five of the cases were subjected to a repeat biopsy after a period of nutritional recovery of 6 to 18 months. The weight had increased to more than 80% of that expected for age.

Ten controls belonging to similar socio-economic class and environment admitted with minor ailments were studied for jejunal brush border disaccharidases.

Statistical analysis was done using Student's paired 't' test, standard error of mean (SEM) and analysis of variance (ANOVA).

Results

Per oral jejunal biopsy was performed in 53 children, 43 clinically diagnosed as malnourished and 10 controls. They belonged to the age group between 3 months to 10 years. In the study group, 28 were females and 15 were males. There were 33 cases of IV degree malnutrition as compared to 2 of I, 1 of 11 and 7 of III degree malnutrition. An interesting finding was that 65% of the children in the study group were girls and 93% of the patients had severe malnutrition. The units of enzyme activity were expressed as micro-moles of substrate hydrolyzed per minute per gram wet weight as well as per gram protein of jejunum. *Table I* shows the values of enzyme activity in the

TABLE I–*Levels of Maltase, Sucrase and Lactase Activities in Normals*

	A Maltase	A Sucrase	A Lactase
n=10			
Mean	72.14	20.9[illegible]	8.76
SD	55.79	16.04	4.43
SEM	17.64	5.07	1.4
Range	28.22-199.43	3.14-48.06	2.66-17.64
	B Maltase	**B Sucrase**	**B Lactase**
Mean	999.97	317.96	128.27
SD	720.72	255.92	86.47
SEM	227.91	80.93	27.34
Range	350.95-2497.56	27.67-808.20	31.34-333.33

A - Enzyme units/g wet wt of mucosa.
B - Enzyme units/g protein.

controls. When enzyme activity was expressed per gram wet weight of jejunum and compared in the patients according to the severity of malnutrition, lactase levels were significantly lower in III and W degree malnutrition ($p < 0.05$ and $p < 0.005$), respectively, as compared to controls as shown in *Table II*. The maltase levels were significantly lower in IV degree malnutrition only ($p < 0.01$). When expressed per gram protein of jejunum, a significantly lower lactase was found in IV degree malnutrition only ($p < 0.001$). On analysis of variance, the mean values of enzyme activity were significantly different across the various groups as depicted in *Table II*. Due to the small number of cases in I and II degree malnutrition, it was difficult to correlate the decrease in enzyme activity with individual degrees of malnutrition.

On estimating the enzyme activity after nutritional improvement, a marginally significant increase was found in maltase and sucrase, than in lactase, as shown in *Table III*. In case 1, a three-fold increase was found in all the three enzymes on recovery. Case 2 showed a more than hundred-fold increase in maltase and about forty-fold increase in sucrase activity, but very little rise in lactase activity. Due to logistic reasons, a limited number of children could be followed up. Hence, it is difficult to come to a conclusion about the recovery of brush border disaccharidases in relation to clinical recovery.

TABLE II–*Levels of Maltase. Sucrase and Lactase as per Degree of Malnutrition*

Degree	Number	Maltase A	Sucrase A	Lactase A
Normals	10	72.14±17.64	20.99±5.07	8.76±1.4
I	2	86.39	25.5	9.35
II	1	19.19	8.68	1.54
III	7	36.89±9.81	7.48±4.12	4.13±0.95*
IV	33	32.60±5.83**	12.91±2.85	3.46±0.93***
		B	B	B
Normals	10	999.97±227.91	317.96±80.93	128.27±27.34
I	2	1949.57	637.37	170.93
II	1	805.96	372.11	64.68
III	7	704.92±190.16	179.14±53.28	76.89±11.26
IV	33	558.29±103.07	208.16±53.84	47.24±17.49****

Values are expressed as mean ± SEM
A-Enzyme units/g wet weight B-Enzyme units/g protein
ANOVA: Mean values were significantly different in A units, across groups (lactase at $p < 0.01$) in B units, across groups (maltase, sucrase at $p < 0.01$)
t-test: Comparison with normals * $p < 0.05$; ** $p < 0.01$; *** $p < 0.005$; **** $p < 0.001$.

TABLE III–*Enzyme Activities in Five Children when Malnourished (M) and after Reocvery (R)*

Cases	A Maltase		A Sucrase		A Lactase	
	M	R	M	R	M	R
1	55.11	195.1	26.46	92.12	3.3	9.26
2	0.44	85.1	0.6	23.81	1.98	2.2
3	17.6	63.27	0.8	19.4	0.44	0.88
4	43.43	74.96	18.52	20.72	1.32	5.73
5	43.75	48.06	0.46	14.99	3.7	2.65
Mean ± SEM	32.07±10.02	93.30±26.19*	9.37±5.5	32.21±14.55**	2.15±0.61	4.14±1.51
	B Maltase		B Sucrase		B Lactase	
	M	R	M	R	M	R
Mean ± SEM	648.18+288.91	1431.04±351.19	227.86±158.67	510.42±188.93	38.93±16.47	60.47±19.55

A-Enzyme units/g wet weight

B-Enzyme units/g protein

By paired 't' test,
* Two-tailed p value = 0.0602 (marginally significant);
** Two-tailed p value = 0.0833 (marginally significant).

Discussion

Most of our cases belonged to the IIIrd and IVth degree malnutrition. Two-thirds of the children were girls and this reiterates the fact about the neglect of the girl child.

We have used two type of units to express the enzyme activity. In the literature, opinion differs as to the usefulness of either of the units. While Sheehy and Anderson feel that the method of expressing is of little consequence, Bowie *et at.* argue that enzyme activity per gram protein of jejunum gives results more consistent with the clinical evidence of diarrhea and disaccharide absorption test(1,5). In our study, however, enzyme activity expressed per gram wet weight jejunum was more commensurate with the severity of affection.

Intestinal mucosal disaccharidase deficiencies have been observed . in children with PEM leading to a diminished capacity to absorb and assimilate dietary carbohydrate(1,7). The disccharidase deficiency may be due to decreased production of the enzyme and/or tissue damage. These deficiencies may persist even after the acute stage of malnutrition(8).
Lactase seems to be the first enzyme to be affected by malnutrition. As the degree of malnutrition increases from III to IV, the

activity of lactase is significantly lowered as compared to controls as shown in *Table II* ($p < 0.005$). In contrast, maltase activity was reduced in only IVth degree malnutrition as compared to the controls. The sucrase activity did not show any significant decrease with increasing severity of malnutrition. It has been proposed that protein depletion *per se* can produce disaccharidase deficiency, presumably by reducing the supply of amino-acids available for enzyme synthesis. Lactase is more severely affected and maltase the least, suggesting that a normal level of lactase activity requires more protein synthesis than does maltase activity, as the epithelial cells migrate up the jejunal villi(8).

Lactase activity was the slowest in recovery in the two cases where all the three enzyme activities were affected. Inspite of a marginally significant increase in the maltase and sucrase levels the improvement in lactase levels on recovery was not statistically significant. Similar results have been shown in other studies(l,7,8).

We conclude that the brush border disaccharidase activity decreases significantly with increasing severity of malnutrition. Lactase is the most severely affected and takes a longer time to recover. The functional improvement is earlier than the structural one. It is important to maintain a sustained improvement in the diet to bring about a total recovery. It seems probable that children with PEM and a damaged intestine, if returned early to a nutritionally inadequate environment, may fail to recover normal levels of disaccharidases and remain permanently with sugar intolerance especially to lactose.

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