THE METABOLISM OF HEALING IN CŒLIAC RICKETS

BY

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As long ago as 1908 it was reported¹ that in intestinal infantilism there was serious derangement of the mineral metabolism. A number of investigations of the calcium and phosphorus metabolism of patients with fatty diarrhœa, both adults and children, have been made at intervals since that time. It has been consistently found that the serum calcium tended to be low, and the serum inorganic phosphorus either normal or sub-normal. Thus, the blood presents the picture of low calcium rickets². Balance studies have shown that the urinary calcium excretion is much reduced, phosphorus excretion diminished, and the fæcal calcium and phosphorus much increased, both relatively and absolutely³⁻⁸. The data in the literature thus suggest that the bone deformities are due to processes similar to those producing infantile rickets. Parsons² in 1927 stated that the bone deformities of cœliac infantilism are rachitic in nature, and that although the blood phosphorus is low, the rickets is of the low calcium type. These conclusions were based on the clinical picture, blood analysis, radiography, and the results of treatment by ultra-violet light or vitamin D.

Gerstenberger and his co-workers⁹, on the other hand, suggested that their conception of the production of primary 'low calcium rickets' does not fit in with the low calcium or combined low calcium low phosphorus types seen in association with cœliac disease. Parsons¹⁰, however, in a later review maintained his former contention, stating that he could see no reason why there should be any distinction between the pathogenesis of the ordinary rickets of infancy and that of cœliac rickets.

In view of this hesitancy to accept cœliac rickets and the ordinary rickets of young children as the same disease in different circumstances, it seemed worth while to record the metabolic observations in the active and healing stages of cœliac rickets, and to compare the results with the changes known to occur in the healing of the infantile type of the disease.

Two patients, girls of six and eight years respectively, presenting the history and clinical characteristics typical of cœliac disease, were found to have active rickets. This was decided on the radiological appearances. In each case the mineral metabolism was studied during this 'active' period. One child (Case 1) was then given radiostol, one tablet, thrice daily; the other (Case 2) adexolin, one capsule, thrice daily; and the metabolic observa-

tions were repeated after treatment, for two weeks (Case 1) and four weeks (Case 2). Each test period lasted for six or seven days. The diet consisted of whole milk with added sugar; the daily ration was kept constant throughout the periods of study and the intervening period of treatment. The choice of diet, unskimmed milk, was justifiable in view of the fact that neither child had diarrhoea at the time. The intake of minerals could be accurately estimated and was ample to meet the children's requirements.

The radiograms showed, in each patient, well marked rachitic change at the beginning of the study. In Case 1, to whom radiostol had been given for only two weeks, the second plate showed little evidence of healing at the time of the second balance period, but a week later there were radiological signs of commencing improvement. In Case 2 the second plate, taken at the time of the second period, showed advanced healing. This child was treated with adexolin.

In each case the percentage fat retention was extremely poor prior to treatment (Table 1). In Case 1, which showed very early healing, it had risen but was still subnormal on the second observation; but in Case 2 it had returned to the normal level.

TABLE 1.
FAT ANALYSIS IN GRM. PER DAY.

	Intake	Fæcal fat				Retention	
		Neutral	Free fatty acid	Combined fatty acid	Total	Total	Percentage
Case 1.							
1	52.08	2.46	3.38	11.63	17.47	34.56	66.4
2	61.41	1.16	2.37	5.06	8.59	52.72	85.8
Case 2.							
1	44.6	0.97	4.27	4.86	10.1	34.5	77.3
2	42.77	0.13	0.09	0.76	0.98	41.79	97.7

Tables 2 and 3 show the figures for the calcium and phosphorus analysis. There was little change in the urinary calcium but definite increase in the

TABLE 2.
URINARY ANALYSIS: DAILY AMOUNTS.

	CaO		P ₂ O ₅		In c.cm. N/10		Volume in c.cm.
	Output in grm.	As % of intake	Output in grm.	As % of intake	Ammonia	Acidity	
Case 1.							
1	.037	1.42	1.687	45	353.4	239	917
2	.021	0.8	1.906	54.2	394.2	305	830
Case 2.							
1	.052	2.6	0.884	33.2	253.3	31.9	730
2	.043	2.06	1.286	45	148	196.2	670

HEALING IN COELIAC RICKETS

357

urinary phosphorus excretion. In Case 2 the urinary ammonia had fallen, and in both Cases 1 and 2 the urinary acidity had increased. All these conform to the findings obtained in the healing of infantile rickets.

Again in the faeces there was great reduction of the output of both CaO and P_2O_5 during healing. In Case 2, in which healing was more advanced, the reduction was so great that the faecal content of calcium and phosphorus was almost negligible. This is also characteristic of infantile rickets in the healing stage.

TABLE 3.

FÆCAL ANALYSIS: DAILY AMOUNTS.

		CaO		P_2O_5		Fæcal weight	Ash percentage
		Output in grm.	As % of intake	Output in grm.	As % of intake		
Case 1.	1.	2.675	103.5	1.813	48.3	32.4	17.08
	2.	1.244	47.6	0.58	16.4	17.53	13.54
Case 2.	1.	1.843	91.4	1.67	62.9	16.7	26.2
	2.	0.13	6.2	0.04	1.4	1.73	14.6

Table 4 summarizes the results. It will be seen that during the 'active' period there was either a negative or an extremely small positive balance, whilst during the 'healing' the retentions were higher than normal figures for children of six and eight years. A similar high level is found in healing rickets.

TABLE 4.

DAILY RETENTION OF CaO AND P_2O_5 IN GRM.

		CaO			P_2O_5		
		Total intake	Total output	Retention per kilo	Total intake	Total output	Retention per kilo
Case 1.	1.	2.58	2.71	-0.009	3.75	3.5	+0.017
	2.	2.61	1.27	+0.092	3.52	2.48	+0.072
Case 2.	1.	2.01	1.9	+0.008	2.66	2.56	+0.007
	2.	2.08	0.17	+0.161	2.86	1.33	+0.129

In Table 5 are given a series of observations for comparison with the figures for coeliac rickets already detailed. In each type of case, infantile, late and coeliac rickets, the alterations in the retention figures, faecal output

and urinary phosphorus output, are very similar. Neither the cases of late rickets of unknown ætiology, nor those with coeliac rickets, show the rise in urinary calcium excretion which appears in the infantile cases. This fact was commented on by Stearns, Oelke and Boyd¹¹ in their paper on the mineral metabolism of late rickets. With this exception the changes are identical.

TABLE 5.

COMPARATIVE TABLE: EXPRESSED IN GRM. PER DAY.

	Rickets	Retention per kgrm.		CaO output		P ₂ O ₅ output	
		CaO	P ₂ O ₅	Urine	Fæces	Urine	Fæces
Infantile rickets. ♂ æt. 10 months	Active Healing	+·037	+·03	·02	1·27	·803	1·003
		+·07	+·066	·044	0·964	·91	0·59
Late rickets ♂ æt. 9 years	Active Healing	—·003	+·002	·01	2·47	1·5	1·71
		+·1	+·08	·015	0·38	1·43	0·26
Normal ♂ æt. 10 years		+·033	+·029	·25	1·82	1·6	1·37

It seems justifiable to conclude from these figures that,

(1) The increase in retention of CaO and P₂O₅ in the rickets of coeliac disease is, with antirachitic treatment, similar to that found in infantile rickets.

(2) Increase in urinary excretion of P₂O₅, decrease in ammonia and increase in the acidity of the urine during healing is similar in the two diseases.

(3) Marked reduction of fæcal output of CaO and P₂O₅ occurs in both.

(4) In view of these findings, in conjunction with the recognized clinical, radiological and blood chemistry changes, there is little room for doubt that the rickets of coeliac disease is of the same nature as ordinary infantile rickets.

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Appendix.

Summary of case reports.

Case 1.—M. R., girl, aged 8 years. Since 1 year old had large abdomen and had been poorly nourished. Was treated as case of tuberculous peritonitis from age of two years. Never had diarrhoea.

Examination showed large abdomen, flattened buttocks, dry skin, and enlargement of epiphyses. Height 101 cm. (expected height 126 cm.). Weight 15.4 kgrm. (expected weight 26 kgrm.).

Admitted 23.1.31. X-ray of wrists 15.1.31 'late rickets.' First metabolism period 31.1.31 to 7.2.31. X-ray four days later showed no healing. Radiostol, 1 tablet t.i.d., commenced on 16.2.31 and second metabolism period began on 27.2.31, continued until 6.3.31. X-ray of 4.3.31 'late rickets,? healing.'

Case 2.—E. A., girl, aged 6 years. Had been treated for coeliac disease for 3½ years.

Examination showed genu valgum, rosary, and enlarged epiphyses. Height 92 cm. (expected height 110 cm.). Weight 13.68 kgrm. (expected weight 19.87 kgrm.).

Admitted on 23.3.31. X-ray 24.3.31 'late rickets.' First metabolism period 21.4.31, after series of X-rays showed that healing was not taking place spontaneously. Adexolin, 1 capsule t.i.d., commenced on 27.4.31 and second metabolism period began on 27.5.31. X-ray of 28.5.31 'rickets healing.'

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