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Radiological diagnosis of lactose intolerance in children with chronic diarrhoea

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One hundred children with chronic diarrhoea and ten without any digestive complaint were subjected to a lactose loading test, with chromatographic study of urine and faeces, and a radiological study of the gastrointestinal tract with a barium-lactose mixture containing 80 g/m² of lactose. A conventional X-ray study using only barium suspension was subsequently made for control purposes. The history of milk intolerance and the clinical response to its withdrawal, as well as symptoms of intolerance during or after the investigations were also recorded.

The patients were classified into four groups according to radiological and laboratory findings. It has been concluded that

a) children without history of lactose intolerance showed normal radiological and loading tests;

b) children with a history of lactose intolerance always showed a pathological lactose X-ray although in some of them loading tests were normal;

c) a correlation was found between positive lactose X-rays, faecal pH, history of milk intolerance and clinical response to lactose withdrawal from the diet;

d) increase of motility was the most frequent and a dilution of the contrast material was the most significant X-ray sign. Gas in colon, distention of loops and gastric retention were also characteristic. Other signs were non-specific;

e) the importance of using 80 g/m² of lactose in subclinical or oligosymptomatic forms of lactase deficiency is stressed;

f) most positive cases had symptoms of intolerance during barium-lactose X-ray studies;

g) the simplicity and reliability of the method recommend its use in any paediatric hospital.

Diarrhoea due to intestinal disaccharidase deficiency occurs in children as well as in adults [4, 11, 12, 18, 35]. Of these disturbances, lactose deficiency is the most frequent one and is considered the most common intestinal disturbance in man [28].

In children, lactase deficiency has a particular interest due to the importance of milk in infant feeding during the first months of life and the frequency of incidence of this disorder as a secondary process in the course of other common diseases at this age, as acute diarrhoeal disease [8, 33, 34], protein-calorie malnutrition [2, 4, 5, 6, 9, 10, 32], coeliac disease [26], giardiasis [26, 30] and many others; congenital forms are much less frequent [13, 16, 21].

The symptoms of disaccharidase deficiency are diarrhoea, flatulency and abdominal cramps. These symptoms appear only when an imbalance exists between jejunal enzymatic capacity and the amount of disaccharide introduced into the gastrointestinal tract [7, 26]. This imbalance may be due to *a)* excessive ingestion of the disaccharide, although a delay in gastric emptying decreases it; *b)* a reduction in length of the gut; *c)* a structural or functional disturbance of jejunal mucosa in enzyme-producing areas [7, 31].

It is thought that the diarrhoea is due to the osmotic effect of non-hydrolyzed lactose in the intestinal lumen [18], but gas and acid production by the intestinal flora acting on non-hydrolyzed lactose also have a role [7, 22, 31].

These disorders can be diagnosed by different methods, from the simplest, which is a dietetic suppression of the non-tolerated sugar [28], to biochemical studies comprising disaccharide loading tests with chromatographic study of urine and faeces [36]; absorption curves; faecal pH; faecal lactic acid estimation, and studies of enzymatic activity in jejunal mucosa obtained by peroral biopsy [1, 7, 31].

Recently, Laws and Neale [19] and Haemerli and Kistler [15] have introduced a radiological method for detecting disaccharide intolerance. When a mixture of barium sulphate and disaccharide is given to a subject with disaccharidase deficiency, the non-hydrolyzed sugar remains without being absorbed in the intestinal lumen, acting as a hydrophilic hypertonic solution, so water from the interstitial compartment dilutes the barium mixture, giving a typical radiological picture in the small intestine and colon, expanding the intestine and increasing motility, producing cramps, flatulency and/or diarrhoea [19, 22, 28]. In addition, gas production can also be detected in the colon [27].

Material and Methods

Two groups of children: 100 patients with chronic diarrhoea admitted to the hospital, or attending the outpatient clinic, and another group of 10 children without any digestive complaint, were studied according to the following plan.

All of them were subjected to lactose loading with chromatographic study of faeces and urine, according to the procedure of Hsia [17] as modified by Menzies and Seakins [24]; and successively, to an X-ray study of the gastrointestinal tract using a mixture of barium sulphate and lactose following the original method of Laws and Neale [19] but with 80 g/m^2 of lactose [12].

According to the results of these investigations, the patients were classified into 4 groups:

- Group I — with normal X-ray and loading tests;
- Group II — with pathologic X-rays and normal loading tests;
- Group III — with normal X-rays and pathologic loading tests;
- Group IV — with pathologic X-rays and loading tests.

Blood sugar was determined by the ortho-toluidine method [29].

Absorption curves were considered normal if the blood sugar increased by more than 30% of the fasting level; doubtful, if the increase was between 20 and 30%; and flat, if it was below 20%.

Subsequently, in each patient a conventional X-ray study of the digestive tract, using only barium sulphate as contrast medium, was performed as control.

Besides, in all the subjects the history was studied for milk intolerance, and in patients with digestive complaints the response to suppression of lactose from the diet was carefully followed, with the purpose of correlating laboratory and X-ray findings with the clinical reaction.

Results

According to the above criteria the patients were distributed as follows.

Group I	15 patients,
Group II	48 patients,
Group III	none,
Group IV	47 patients.

Group I. As Table I shows, fifteen children showed neither X-ray nor laboratory abnormalities. Of these fifteen, five were children with trichuriasic enterocolitis and the other ten were normal from the gastrointestinal point of view.

Table I

Findings in 15 children of group I (normal X-rays and loading tests)

Barium-lactose X-ray study of g. i. tract	All normal
Conventional X-ray study of g. i. tract	All normal
Lactose absorption curves ..	All normal
Chromatography of urine & faeces in loading tests ..	All negative
Milk intolerance	Absent in all
Mean faecal pH	7.1 ± 0.4

Mean value for faecal pH was 7.1 ± 0.4.

Group II. Analyzing this group, we soon realized that is was not really homogeneous, and that it was necessary to make two distinct subgroups: II–A — children with a history of milk intolerance and a favourable response (disappearance of diarrhoea) to lactose withdrawal from the diet (Table II), and II–B — children without a history of milk intolerance but in whom the diarrhoea failed to disappear on lactose suppression (Table III).

Table II

Findings in 14 children of subgroup II-A (pathologic X-rays, normal loading tests, milk intolerance)

Radiological findings	Ba+Lactose X-rays No	Conventional X-rays No
Increase of motility	14	2
Dilution in jejunum	13	0
Expansion of loops	12	0
Fragmentation of barium meal	9	4
Gastric retention	3	0
Gas in colon	13	0
Dilution in colon	3	0
Decrease of motility	1	2
Total No. of patients	14	14

Lactose absorption curves	Normal: 14 cases
Chromatogram of urine (after loading tests).	Positive: 10 cases
Chromatogram of faeces (after loading tests).	Positive: 0 case
Mean faecal pH......	6.1 ± 0.7
Milk intolerance......	Present: 14 cases
Response to lactose withdrawal from diet	Positive: 14 cases

From the comparison of these two subgroups, it was evident that in II–A, although the lactose tolerance curve was normal and no sugar was detected in the faeces, we found

TABLE II-A

Basic diseases in 14 children of subgroup II-A

Basic disease	No. of cases
History of acute diarrhoeal disease	7
Coeliac disease	3
Giardiasis	3
Unknown	1
Total No. of patients	14

lactosuria in ten of 14 patients; a mean faecal pH significantly lower ($p < 0.001$) than in group I; and a pathological barium-lactose X-ray. Meanwhile, conventional studies showed only few abnormalities or none.

TABLE III

Findings in 34 children of subgroup II-B (pathologic X-rays, normal loading tests, no milk intolerance)

Radiological findings	Ba+Lactose X-rays No	Conventional X-rays No
Fragmentation of barium meal	22	10
Increase of motility	13	7
Expansion of loops	10	0
Decrease of motility	4	6
Gastric retention	2	0
Dilution in jejunum	2	0
Gas in colon	0	0
Dilution in colon		0
Total No. of patients	34	34

Lactose absorption curves	Normal:	34 cases
Chromatograms in urine (after loading tests).	Positive:	6 cases
Chromatograms in faeces (after loading tests)	Positive:	0 case
Mean faecal pH	7.0 ± 0.5	
Milk intolerance......	Absent:	34 cases
Response to lactose withdrawal from diet	Negative:	34 cases

TABLE III-A

Basic diseases in 34 children of subgroup II-B

Basic disease	No. of cases
Trichuriasis	10
Giardiasis	7
Amoebiasis histolytica	4
Protein-calorie malnutrition	4
Disbacteriosis	4
Mucoviscidosis	2
Salmonellosis (Salmonella B)	1
Ulcerative colitis	1
Cystic lymphangioma of the gut	1
Total No. of patients	34

TABLE IV

Findings in 47 children of group IV (pathologic X-rays and loading tests)

Radiological findings	Ba+Lactose X-rays No	Conventional X-rays No
Increase of motility	40	5
Dilution in jejunum	32	0
Gas in colon	31	0
Fragmentation of barium meal	28	4
Expansion of loops	26	4
Gastric retention	11	0
Dilution in colon	6	0
Decrease of motility	3	0
Total No. of patients	47	47

Lactose absorption curves	Abnormal:	47 cases
Chromatograms in urine (after loading tests)	Positive:	47 cases
Chromatograms in faeces (after loading tests)	Positive:	47 cases
Mean faecal pH ...	5.6 ± 0.6	
Milk intolerance ...	Present:	47 cases
Response to lactose withdrawal from diet	Positive:	47 cases

In subgroup II-B, fewer patients had lactosuria; the pH was not significantly different ($p > 0.05$) from those of group I; and less pathological findings were present in both X-ray studies, particularly specific ones as dilution and acceleration of peristalsis.

Tables II-A and II-B show the basic disease in children of subgroups II-A and II-B. It is evident that there is a great difference between the causes of diarrhoea in both subgroups.

Group III. No patients fulfilled the criteria of classification into this group.

Group IV. Table IV shows the results for the 47 children belonging to this group. In all of them, the lactose absorption curve was flat or doubtful; chromatographic studies were positive in faeces and urine; and faecal pH was significantly lower ($p < 0.001$) than in any other group.

Radiological findings were similar to those of subgroup II-A.

Table IV-A shows the diagnosis of all the cases of group IV; they were similar to those of subgroup II-A.

TABLE IV-A

Basic diseases in 47 children of group IV

Basic disease	No. of cases
History of acute diarrhoeal disease	23
Coeliac disease	9
Protein-calorie malnutrition	9
Giardiasis	4
Unknown	2
Total No. of patients	47

TABLE V

Correlation between X-ray findings and lactose absorption curves in 47 children of group IV

X-Ray findings / Lactose absorption curve	Doubtful (20—30%) No	Flat <20% No
Increase of motility	9	31
Dilution in jejunum	6	26
Gas in colon	7	24
Fragmentation of barium	8	20
Expansion of loops	6	20
Gastric retention	3	8
Dilution in colon	2	4
Decrease of motility	1	2
Total No. of patients	10	37

TABLE VI

Accompanying symptoms in children with positive barium-lactose X-ray studies

Symptoms	Sub-group II-A No	Sub-group II-B No	Group IV No
Diarrhoea	11	3	39
Abdominal cramps	3	2	8
Vomiting	5	2	6
Total No. of patients	14	34	47

Table V separates the patients from this group according to the results of the absorption curve making a comparison of X-ray findings in both categories: no significant differences were found in respect of the main radiological features.

Radiological findings

Increase of motility or acceleration was the most frequent feature found in children with pathological X-rays with the barium-lactose mixture, followed in frequency by a dilution of the contrast material in the jejunum and/or colon (Fig. 1). This dilution was found to represent the key sign in the X-ray diagnosis of disaccharide intolerance (Figs 3, 4, 7, 9).

Fragmentation or a "patchy pattern", a sign of malabsorption, was frequently seen in pathological cases, but the finding is non-specific (Figs 2, 8).

Distension of intestinal loops was also an important sign but not as constant as dilution or acceleration (Fig. 5).

Of particular interest was the gastric retention found in 11 children from group IV in lactose-barium X-ray studies, while it was not present in any of the conventional X-ray studies carried out in the same patients.

Presence of gas in the colon occurred in 13 of 14 children of subgroup II-A and in 31 of 47 patients of group IV (Fig. 6).

In children from other groups conventional or barium-lactose X-ray studies never revealed the presence of gas in the colon.

Accompanying symptoms in children with positive barium-lactose X-ray studies

None of the children of group I had clinical symptoms of lactose intoler-

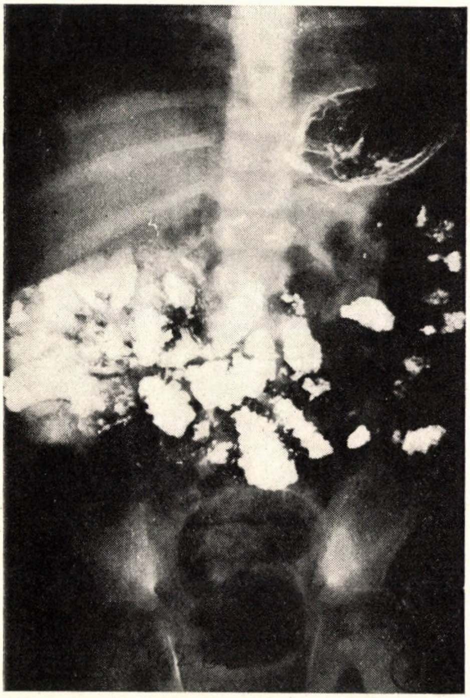

FIG. 1. Digestive tract X-ray study 30 minutes after a barium-lactose meal. Increase of motility, fragmentation and dilution of barium meal in jejunum and colon

FIG. 2. Ninety minutes after a barium-lactose meal. Fragmentation and oedema of jejunal mucosa

ance during the radiological study or afterwards. However, as seen in Table V, a number of patients belonging to subgroup II-A and group IV had digestive complaints of which diarrhoea was the most common. A small percentage of children from subgroup II-B also displayed these symptoms.

Discussion

As lactase deficiency is the most frequent digestive disturbance in man, it is obvious that attempts at finding easy diagnostic methods are made everywhere. Undoubtedly, the simplest diagnostic point is the relationship between diet and digestive symptomatology. This relationship has made us to divide a group, which was theoretically homogeneous, into two subgroups with diverse peculiarities giving us the reassurance of the diagnostic value of radiology.

The amount of lactose employed by us, 80 g/m^2 body surface, was well tolerated in normal cases and they showed no digestive complaints during or after the investigation. BRUSILOW et al. [7] pointed out that this amount allows to detect subclinical or oligosymptomatic forms of lactose intolerance, which is not possible by the use of 50 g/m^2.

Actually, we found that not only in children without diarrhoea but also in those displaying no symptom

FIG. 3. Thirty minutes after a barium-lactose meal. Dilution in jejunal loops

FIG. 4. Two hours after a barium-lactose meal. Dilution in jejunal loops

of milk intoleran ce the dose used by us did not induce digestive complaints, so that there is no risk of false positive results.

In subgroup II-B, barium-lactose X-ray studies revealed more pathological findings than did conventional examinations, but there was neither a dilution of the contrast material nor an increase in motility, or presence of gas in the colon. Therefore, we considered these pathological findings non-specific, while dilution, acceleration and gas in colon were highly specific.

Mean pH values and lactosuria in almost $^{3}/_{4}$ of the cases of subgroup II-A, together with the high frequency of accelerated peristalsis and dilution of the contrast material with clinical symptoms of intolerance during and/or after the X-ray test allowed to establish clinical-radiologic correlations which were more close than those between the clinical aspect and the laboratory tests. Therefore, for the detection of lactose intolerance radiology seems to be a more sensitive indicator than are laboratory results.

In group IV, a correspondence of the results of loading tests with radiological positivity was noted. In cases with doubtful absorption curves the radiological findings were always deciding the issue. Dilution of the contrast material was the most valuable sign because it was found in none of the conventional studies.

FIG. 5. Conventional digestive tract X-ray study, ninety minutes after a barium meal. Normal

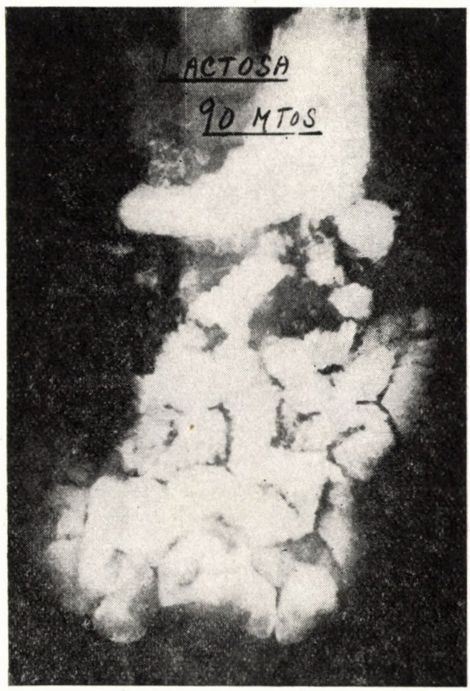

FIG. 6. Same case as in Fig. 5 ninety minutes after a barium-lactose meal. Distention of loops, dilution and gas in colon

Gastric retention too was an important finding being present in $^1/_4$ of the children from this group and in none of the conventional examinations.

McNeish and Sweet [23] found in a study of 24 children with coeliac disease four patients with lactose intolerance, all four displaying dilution of the contrast material and distension of jejunal loops. About one fourth of our patients of subgroup II-A and group IV were coeliacs, but there were no coeliacs in any of the other groups.

About one half of the cases of lactose intolerance had arisen secondary to acute diarrhoeal disease. Protein-calorie malnutrition and giardiasis were frequently found, but as these conditions were also present in some children of subgroup II-B, we concluded that lactase deficiency is not a regular concomitant of these conditions.

Besides the diagnostic advantages of radiological studies with a barium mixture using 80 g/m^2 of lactose, there is the observation of other authors about the possibility of false negative results in loading tests. Gastric retention may modify lactose absorption [25] and a rapid utilization of glucose by the cells may also lead to false positive results. On the other hand, the radiological method allows the assessment of the osmotic effect of the disaccharides and of the pres-

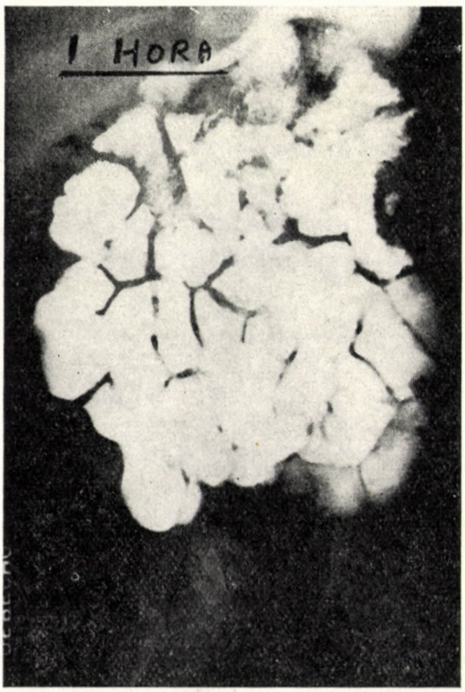

Fig. 7. One hour after a barium-lactose meal. Distention of loops and dilution

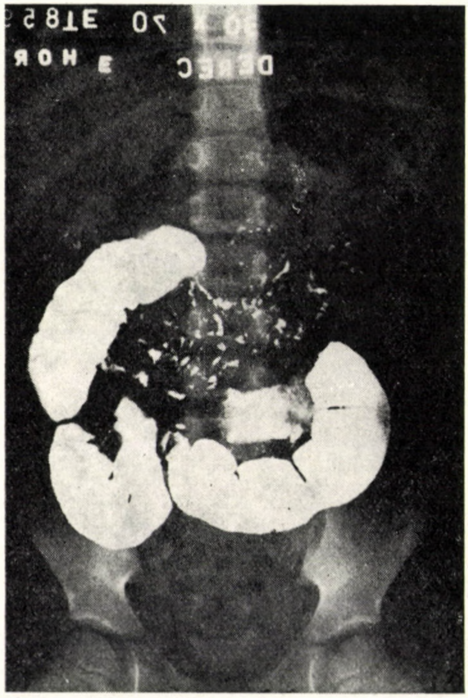

Fig. 8. Three hours after a barium-lactose meal, distention of loops and decrease of motility, and "snow pattern"

FIG. 9. Same case as in Fig. 7, two hours later. Dilution of barium meal in colon

ence of structural lesions, being independent of the rate of glucose blood [19, 20]. Thus, the reliability of this simple test recommends its use in any paediatric hospital.

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