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Oral fat loading test

A reliable procedure for the study of fat malabsorption in children

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SUMMARY Oral triglyceride (TG) loading tests were performed in four groups of children: normal controls, patients with chronic nonspecific diarrhoea (CND), biopsy-proved mucosal pathology (MP), and disturbed intraluminal fat malabsorption (IFM). The rise of plasma TG levels $\geqslant$55 mg/100 ml ($\geqslant$0·6 mmol/l) can discriminate between patients with gastrointestinal disease and normal controls or patients with functional disturbances. The postmeal plasma TG rise correlates well with the coefficient of fat absorption (CFA) in normal subjects, patients with CND, and patients with IFM, but not in patients with MP who showed a disproportionally low plasma TG rise compared with their CFA. This test can serve as a useful tool in diagnosis and clinical evaluation for children with gastrointestinal disorders.

The evaluation of fat absorption is based mainly on balance studies, measuring intake and output over a particular period. The technical difficulties, especially that of reliable stool collection, have limited the use of this method. Other techniques using loading tests of iodine-labelled (Barbieri *et al.*, 1968) or ^{14}C-labelled fat (Shigekoto and Wagner, 1968) depend on accurate urine or expired air collections and pose similar problems. Plasma triglyceride (TG) increase after oral fat load has been found useful in evaluating fat malabsorption in children with a variety of gastrointestinal diseases (Norman *et al.*, 1971; Fällström *et al.*, 1977). The reliability of this method to determine various degrees of fat malabsorption has not yet been investigated, nor has this method been used in children with chronic nonspecific diarrhoea (Davidson and Wasserman, 1966).

We used the oral fat load to evaluate the correlation between the rise in plasma TG after a test meal and the coefficient of fat absorption in various disorders, including that of chronic nonspecific diarrhoea.

Patients and methods

21 children with no gastrointestinal symptoms aged between one month and 14 years were compared with three groups of patients: (a) 14 children aged between 5 months and 8 years with chronic nonspecific diarrhoea (CND) and normal or transiently delayed weight gain, in whom no gastrointestinal disease could be shown; (b) 17 patients aged between 4 months and 14 years with biopsy-proved intestinal mucosal pathology (MP). This group comprised 13 patients with gluten-sensitive enteropathy, and 4 babies with postgastroenteritis malabsorption; (c) 12 patients aged between one month and 8 years with intraluminal fat malabsorption (IFM), This group comprised 7 patients with cystic fibrosis and 5 children with bacterial overgrowth as shown by duodenal fluid culture.

Fat was determined on 72-hour stool collections using a gravimetric method (Jeejeebhoy *et al.*, 1970). In small children stools were collected with the aid of metabolic frames. Fat intake was measured during the collection period and the coefficient of fat absorption (CFA) calculated according to the formula: (fat intake – fat output) × 100/fat intake. The TG loading test was performed after a 6-hour fast in small children and after a 12-hour fast in older ones. The meal consisted of Blue Band margarine, 2 g/kg, mixed with cocoa powder and saccharine, to form a cream of acceptable taste. The fatty acid composition of this margarine is 19·5% saturated (12%-palmitic, 7·5%-stearic), and 80·5% unsaturated (43·8%-oleic, 32%-linoleic, and 4·7%-linolenic). Small babies and reluctant toddlers were intubated. In the latter case the mixture was melted to a maximum temperature of 60°C. Blood was

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drawn at periods of 0, 2, and 4 hours after fat ingestion. Plasma TG levels were determined fluorimetrically using a Technicon AAII (Kessler and Lederer, 1965).

Results

Fasting plasma TG levels varied widely and there was no difference between the groups. Two hours after ingesting the test meal, both control and CND groups showed a constant and significant rise in plasma TG (Table). Although the patients with CND had lower levels than controls, they were clearly distinct from both groups with IFM and MP who showed a slight rise in plasma TG levels. Fig. 1 shows the 2-hour rise of plasma TG in each patient. None of the children with gastrointestinal disease showed a rise >40 mg/100 ml (>0·4 mmol/l). Of the 29 patients studied, 11 had no rise at all and some even had a decrease in plasma TG values. They differed significantly from controls and patients with CND who exceeded a slight rise of 55 mg/100 ml. The only exception, a 4-year-old child with recurrent diarrhoea, had also a borderline coefficient of fat absorption of 88% but no other evidence of gastrointestinal disease.

The 4-hour postloading TG values tended to return to preloading levels in most children and were not useful in identifying the various groups. These values are therefore not presented here.

By comparing the 2-hour plasma TG values with the CFA ones (Fig. 2), a significant correlation was obtained in controls ($R = 0{\cdot}84$ $y = -679{\cdot}21 + 8{\cdot}7 \times P<0{\cdot}001$), CND ($R = 0{\cdot}77$ $y = -801{\cdot}1 + 9{\cdot}4 \times P<0{\cdot}001$), and patients with IFM ($R = 0{\cdot}61$ $y = -95{\cdot}1 + 1{\cdot}3 \times P<0{\cdot}05$). Only the MP group had a much lower plasma TG increase compared with their CFA, and accordingly no signiffcant correlation was observed ($R = 0{\cdot}47$, P = NS).

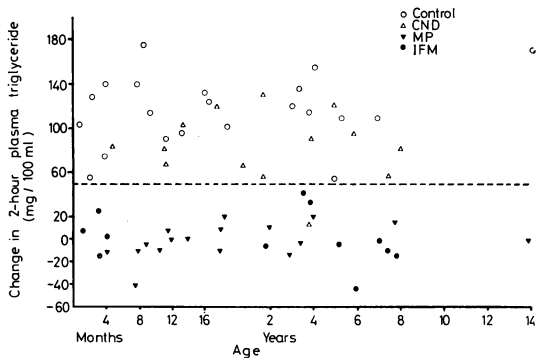

Fig. 1 *Two-hour rise in plasma triglyceride values after an oral fat load in various groups of patients. Broken line at 50 mg/100 ml separates patients with fat malabsorption from controls and those with CND.*

Discussion

The results of this study show that a 50 mg/100 ml (0·6 mmol/l) rise in plasma TG levels 2 hours after an oral fat load can serve as a useful screening procedure for separating children with gastrointestinal disease from controls and from children with CND. The inexpensive fluorimetric method proved adequate and gave results comparable with those using more expensive gas liquid chromatography (Fällström *et al.*, 1977). The procedure should thus be available routinely in clinical laboratories.

The good correlation between CFA and 2-hour rise of plasma TG levels in most children including normal controls, children with CND and IFM, suggest that this test is a reliable reflection of the processes of fat absorption in most conditions. Accordingly it may serve in evaluating various therapeutic measures in children with cystic fibrosis, bacterial overgrowth, and cholestasis. Patients with MP failed to show this correlation. In these conditions the greater disturbance of fat absorption in the proximal intestine is illustrated by the low 2-hour rise of plasma TG levels. The relatively higher CFA is possibly the result of some compensation brought about by absorption in distal, less involved parts of the gut. This may explain the better discriminating capacity of this test compared with

Table *Plasma triglycerides, stool fat, and coefficient of fat absorption (CFA) (means ± SD) in the various groups of children*

Group	*Plasma triglycerides (mg/100 ml)*			*Stool fat (g/24h)*		*CFA % intake*	
	Fasting	*2-h postmeal rise*	*P*		*P*		*P*
Controls (n = 21)	115·5 ± 87·8	116·0 ± 33·9	—	1·5 ± 0·9	—	94·8 ± 2·8	—
CND (n = 14)	81·4 ± 45·8	82·1 ± 31·8	<0·01†	1·6 ± 0·8	NS	95·4 ± 2·7	NS
MP (n = 17)	99·4 ± 49·0	0·6 ± 14·7	<0·01	4·0 ± 2·6	<0·01*	83·3 ± 5·5	<0·01*
IFM (n = 12)	85·8 ± 29·6	1·2 ± 24·9	<0·01	11·3 ± 8·2	<0·01	74·6 ± 11·4	<0·01

P compared with control, *compared with IFM, †compared with both IFM and MP.
Conversion: traditional units to SI—triglyceride: 1 mg/100 ml ≈ 0·0113 mmol/l, stool fat: 1 g/24 h ≈ 3·52 mmol/24 h.

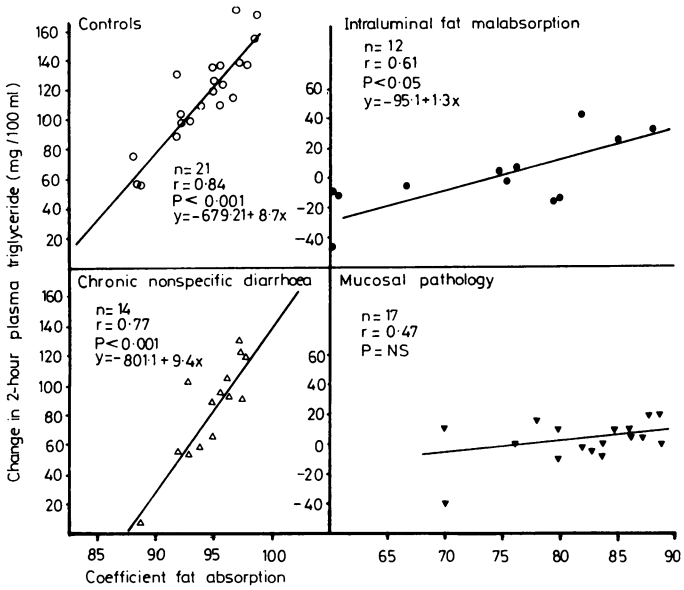

Fig. 2 *Relation between the rise in plasma triglyceride levels 2 hours after the test meal and the coefficient of fat absorption.*

faecal fat measurement in patients with gluten entropathy (Fällström *et al.*, 1977). The test may prove useful in early evaluation of gluten challenge, notably the timing of postchallenge biopsy.

Children with CND constitute the bulk of clinical material seen in most gastrointestinal services. This group demonstrated a lower increase in plasma TG levels compared with normal subjects, yet, with a single exception, they could easily be separated from patients with gastrointestinal disease. Borderline CFA had previously been reported in some of these children (Davidson and Wasserman, 1966); the significance of this observation is still not known.

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References

Barbieri, D., Campos, J. V. M., Marcondes, E., and Quarentei, G. (1968). Behaviour of the lipidol test in malabsorption syndromes. *Archivos de gastroenterologia y nutrición*, **5**. 173–178.

Davidson, M., and Wasserman, R. (1966). The irritable colon of childhood (chronic nonspecific diarrhea syndrome). *Journal of Pediatrics*, **69**, 1027–1038.

Fällström, S. P., Nygren, C. O., and Olegård, R. (1977). Plasma triglyceride increase after oral fat load in malabsorption during early childhood. *Acta paediatrica Scandinavica*, **66**, 111–116.

Jeejeebhoy, K. N., Ahmed, S., and Kozak, G. (1970). Determination of fecal fats containing both medium and long chain triglycerides and fatty acids. *Clinical Biochemistry*, **3**, 157–160.

Kessler, G., and Lederer, H. (1965). Fluorimetric measurement of triglycerides. In *Automation in Analytical Chemistry*, Technicon Symposia, p. 341. Edited by L. T. Skeggs, Jr. Mediad: New York.

Norman, A., Stranduik, B., and Zetterstrom, R. (1971). Test meal in the diagnosis of malabsorption in infancy. *Acta paediatrica Scandinavica*, **60**, 165–172.

Shigekoto, K., and Wagner, H. N., Jr (1968). Measurement of intestinal fat absorption with C^{14} labelled tracers. *Journal of Laboratory and Clinical Medicine*, **71**, 400–411.

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