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## Lactose absorption, milk consumption, and fasting blood glucose concentrations in women with idiopathic osteoporosis

G FINKENSTEDT, F SKRABAL, R W GASSER, H BRAUNSTEINER

### Abstract

Lactose tolerance tests were performed in 33 women with osteoporosis and 33 control women matched for age. A questionnaire was used to elicit any history of milk intolerance and the subjects' daily intake of calcium derived from milk and dairy products. Eleven patients and four controls gave a history of milk intolerance ( $p < 0.01$ ); 13 patients had lactose malabsorption compared with four controls ( $p < 0.01$ ). The daily intake of calcium derived from milk was significantly lower in patients (125 (SEM 20) mg *v* 252 (43) mg;  $p < 0.05$ ). Curves of blood glucose concentrations during the lactose tolerance test in subjects with lactose malabsorption were significantly flatter in patients than controls ( $p < 0.05$ ). The fasting blood glucose concentration was higher (5.44 (0.17) mmol/l (98 (3) mg/100 ml)) in the patients than the controls (4.88 (0.11) mmol/l (88 (2) mg/100 ml);  $p < 0.05$ ), although body weight was significantly lower (61.6 (2.2) kg *v* 66.3 (1.6) kg;  $p < 0.05$ ).

Absorption of lactose is significantly impaired in women with "idiopathic" osteoporosis; this combined with low consumption

of milk and a subclinical disorder of glucose metabolism may be a major factor in the development of idiopathic osteoporosis in women.

### Introduction

The contribution of malabsorption of lactose to the development of osteoporosis is not well documented. Birge *et al* and Newcomer *et al* found an increased incidence of lactose intolerance in patients with osteoporosis,<sup>1,2</sup> while Alhava *et al* could not show any difference in bone mineral content between subjects with and without lactose intolerance.<sup>3</sup> We determined the prevalence of lactose malabsorption and the amount of calcium consumed that was derived from milk and dairy products in 33 women with osteoporosis compared with 33 control women matched for age.

### Patients, methods, and results

Thirty three women aged under 65 with "idiopathic" osteoporosis were compared with 33 women without osteoporosis (Singh index  $> 4$ ) of the same ethnic origin matched for age. We excluded patients with endocrine disorders, liver and renal disease, postgastroectomy states, malabsorption syndromes, rheumatoid arthritis, osteomalacia, and malignancy and patients receiving corticosteroids. Patients and controls were not taking drugs that influenced calcium or bone metabolism. Osteoporosis was confirmed by the presence of reduced bone mineral density in plain x ray films and either a femoral trabecular index  $< 5^4$  or the presence of spontaneous fractures of vertebrae or long bones, or both.

Malabsorption of lactose was defined as a rise in glucose concentration of  $< 1.11$  mmol/l (20 mg/100 ml) in capillary blood samples taken at 30 minute intervals after the ingestion of 50 g lactose dissolved in water.<sup>5</sup> Patients were given a questionnaire asking about their mean daily or weekly ingestion of milk, yoghurt, cottage cheese, and other cheese and about tolerance to

Department of Internal Medicine, University Hospital, University of Innsbruck, 6020 Innsbruck, Austria

G FINKENSTEDT, MD, senior registrar

F SKRABAL, MD, professor, chief of division of endocrinology and hypertension

R W GASSER, MD, senior registrar

H BRAUNSTEINER, MD, professor of internal medicine and head of department

Correspondence to: Dr Finkenstedt.

milk in childhood and later life. The daily calcium intake derived from milk and dairy products was calculated according to standard nutritional tables.<sup>6</sup>

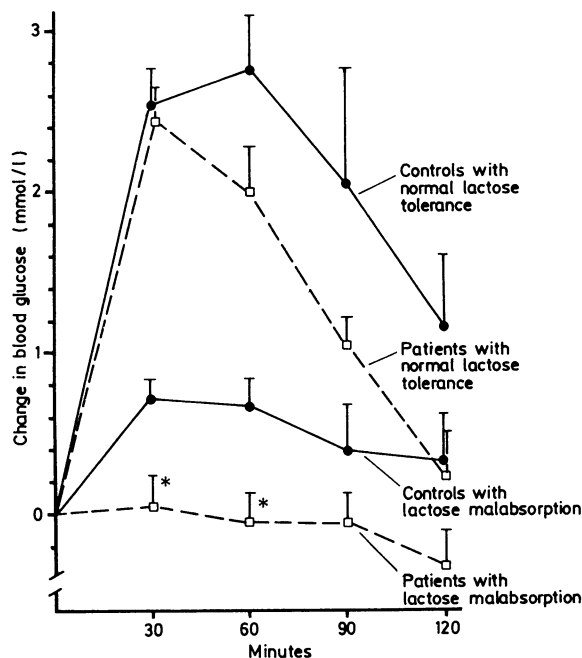
Significance was assessed with the Mann-Whitney U test.

The table gives the clinical and biochemical data on the patients with osteoporosis and the controls. The prevalence of lactose malabsorption and of milk intolerance was significantly higher in the patients. The mean daily

Clinical and biochemical data on women with osteoporosis and controls matched for age

	Patients (n=33)	Controls (n=33)	P
Mean age (range) (years)	54 (31-65)	56 (33-67)	
No of patients with fractures	14		
Mean trabecular index (range)	3 (2-4)	5 (5-6)	
Mean (SEM) body weight (kg)	61.6 (2.2)	66.3 (1.6)	<0.05
No with lactose malabsorption	13	4	<0.01
No with history of milk intolerance	11	4	<0.01
Mean (SEM) total daily calcium intake from milk and dairy products (mg)	429 (62)	645 (127)	NS
Mean (SEM) daily calcium intake from milk (mg)	125 (20)	252 (43)	<0.05
Mean (SEM) serum calcium (mmol/l)	2.40 (0.02)	2.38 (0.01)	NS
Mean (SEM) serum alkaline phosphatase (U/l)	137 (12)	95 (6)	<0.01
Mean (SEM) fasting blood glucose (mmol/l)	5.44 (0.17)	4.88 (0.11)	<0.05
Mean (SEM) change in blood glucose during lactose tolerance test (mmol/l) at:			
30 min	1.33 (0.28)	2.11 (0.28)	<0.05
60 min	1.00 (0.28)	2.05 (0.33)	NS
90 min	0.50 (0.17)	1.55 (0.55)	<0.05
120 min	0.00 (0.17)	0.94 (0.33)	<0.05

Conversion: SI to traditional units—Calcium: 1 mmol/l ≈ 4 mg/100 ml. Glucose: 1 mmol/l ≈ 18 mg/100 ml.



Increases in blood glucose concentrations during lactose tolerance test in patients with osteoporosis and controls with and without lactose malabsorption.

\* $p < 0.05$ .

Conversion: SI to traditional units—Glucose: 1 mmol/l ≈ 18 mg/100 ml.

total calcium intake derived from milk and dairy products was marginally lower in the patients, whereas their daily calcium intake derived from milk was significantly lower. Unexpectedly, the fasting blood glucose concentrations were significantly higher in the patients, although their mean body weight was significantly lower. The increases in blood glucose concentration during the lactose tolerance test were significantly lower in the patients at 30, 90, and 120 minutes.

Increases in blood glucose concentrations during the lactose tolerance test were significantly lower at 30 and 60 minutes in the osteoporotic women with lactose malabsorption compared with the controls with lactose malabsorption. The same trend, though not significant, was observed in the patients and controls with normal lactose tolerance (figure).

## Discussion

Although computed tomographic estimation of lumbar spine bone mineral content was not available at the start of the study, we believe that osteoporosis is confirmed by either a low trabecular index<sup>4</sup> or the presence of spontaneous fractures, or both.

Our study confirms the finding of Newcomer *et al* of a high prevalence of lactose intolerance in postmenopausal women with osteoporosis compared with control women matched for age.<sup>2</sup> Thus lactose malabsorption appears to be associated with the development of osteoporosis in women. The increased prevalence of lactose malabsorption in women with osteoporosis is reflected by the increased prevalence of milk intolerance in these patients.

Furthermore, we found that the daily calcium intake derived from milk was significantly lower in women with osteoporosis while total daily calcium consumption was only marginally lower. To our knowledge, this is the first study that has shown differences in milk (and milk calcium) consumption between women with osteoporosis and controls. Previous studies assessed total daily calcium intake, which was not different between the two groups.<sup>1,2</sup> Though aware that estimates of dietary calcium intake are notoriously inaccurate, we believe that estimates of the calcium intake derived from milk are more reliable. Thus low milk consumption seems to be a further important factor in the development of osteoporosis in women.

Comparison of the blood glucose curves during the lactose tolerance tests between those with and without lactose malabsorption (figure) showed that the usual definition of lactose malabsorption as a rise in blood glucose concentration of less than 1.11 mmol/l (20 mg/100 ml)<sup>5</sup> is arbitrary. Thus the increments in blood glucose concentration at 30 and 60 minutes in the group defined as having lactose malabsorption were significantly different between the patients with osteoporosis and the controls; in fact, blood glucose concentration virtually did not increase at all in this group of patients. Lactose tolerance curves were also flatter in patients with "normal" lactose absorption compared with corresponding controls (figure). Thus lactose absorption seems to be a gradual continuum from frank malabsorption to minor changes that may not cause clinical symptoms but may predispose to the development of osteoporosis over many years.

Interestingly, fasting blood glucose concentrations were significantly higher in the women with osteoporosis, although their body weight was lower. As diabetes mellitus is thought to predispose to osteoporosis<sup>7</sup> this observation may point to a disturbance of glucose homeostasis as an additional contributing factor in the development of osteoporosis. We are at present investigating glucose metabolism in these patients in detail, especially to exclude simple explanations such as a lesser degree of physical activity in patients with osteoporosis.

In conclusion, this study shows that lactose absorption is significantly impaired in women with idiopathic osteoporosis; low milk consumption and a subclinical disorder of glucose metabolism may be contributing factors in the development of osteoporosis.

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