Contemporary Themes

Dietary management of maturity-onset diabetes

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Summary and conclusions

Dietary management of maturity-onset diabetes is a basic medical concept. It is difficult to study scientifically because of variable eating habits and the impossibility of rigorous measurement. The non-insulin-requiring diabetic patient is often managed by the family doctor, who may not have access to dietetic assistance, and assessment of the success of simple but careful dietary measures is infrequent. We have taken a special interest in this group of patients, and find that most maturity-onset diabetic patients can be satisfactorily managed on diet only.

In a group of 58 such patients there was a significant fall in mean weight and fasting plasma glucose and triglyceride concentrations after six months, which persisted for up to three years. This achievement was chiefly due to those patients who were graded as "good" in their dietary adherence, but less good dieting still achieved weight loss, though plasma glucose and triglyceride concentrations did not fall so low. The clinical dietitian has played a central part in this study.

Introduction

There has been a resurgence of interest in the dietary management of maturity-onset diabetes mellitus (non-insulin-dependent diabetes) during the past 10 years. In part this stems from a reasonable reaction against the indiscriminate use of oral hypoglycaemic agents in diabetes following the report in 1970 of the University Group Diabetes Program¹ and other corroborative studies.²⁻⁴

Furthermore, in the USA there has been a general restatement of possible dietary goals with regard to ischaemic heart disease relating to food consumption, which has some relevance to Britain.⁵ It has been suggested that carbohydrate should be increased to 55-60% of the energy content of the normal diet, with fat reduced from over 40% to under 30%, and protein thus reduced to about 10% of the dietary energy. Although ischaemic heart disease is the major prognostic factor in maturity-onset diabetes, these goals are open to considerable debate, both in percentage and absolute terms. A recent statement from the Royal College of Physicians of London and the British Cardiac

Society⁶ has also suggested that traditional diets for diabetics have been proportionately high in fat and thus possibly atherogenic. (The difference between a proportional and an absolute value must be remembered—a proportionately high fat diet need not necessarily have a high absolute fat intake: it will depend on the total energy value of the diet.)

Attempts to review the evidence regarding the dietary treatment of diabetes have suggested that even what current effort there is in diet counselling it is ineffective and wasteful.⁷ There is clearly still much uncertainty about the best dietary policy for diabetics and the best ways of helping patients to follow the regimen prescribed.⁸

Dietary programme

We present data on the result of careful monitoring of a specific dietary programme in a group of maturity-onset diabetic patients in Northern Ireland, all of whom have been observed for three years since diagnosis. The main dietary modification to produce overall energy restriction was exclusion of sucrose and sucrose-containing foods to give an approximate energy intake of 6 MJ (1435 kcal), 150 g carbohydrate (42%), 70 g protein (20%), and 60 g fat (38%). This group is part of a larger continuing programme of dietary treatment of maturity-onset diabetes.⁹ All such patients referred to the diabetic clinic at this hospital aged 40-70 years have been eligible for inclusion, either if they had classic symptoms related to hyperglycaemia or those asymptomatic patients whose initial diagnostic glucose tolerance test showed very high (>20 mmol/l; 360 mg/100 ml) plasma glucose values. A relatively high "cut-off point" for the definition of diabetes mellitus has now been recommended by several epidemiological studies,^{10,11} and clearly this group will differ in many respects from some previous studies where "borderline" and "mild" diabetes were studied. Details of the organisation of the study and the biochemical techniques used have been published.⁹ We concentrate on the dietetic aspects with regard to 58 of these patients, all of whom have been regularly observed over a three-year period.

The dietitian gave dietary instruction at the initial visit to the hospital after a brief explanation of the proposed dietary management by the doctor. Patients were seen by the dietitian either individually or when necessary with relatives. A home visit by a health visitor attached to the clinic followed this first consultation. The initial dietary instruction given by the dietitian was considered to be most important. Dietary advice was closely related to the socioeconomic circumstances of individual patients, bearing in mind that eating patterns are well-established. In general terms it was recognised that a high energy intake including a high intake of both starch and protein is commonplace in Northern Ireland, so a simple approach to dietary management was adopted, and the positive aspects of good nutrition were emphasised. The diet was prescribed initially on an energy basis with restricted carbohydrate and excluding sucrose and sucrose-containing foods. Monosaccharides (glucose and fructose) and disaccharides (sucrose and lactose) were forbidden as food additives. Energy intake was further restricted for patients who were also overweight. The aim was to achieve the average weight for height and age for each individual.¹² The more complex dietetic aspects, including food exchanges (apart from simple 10 g carbohydrate portions) were not discussed, and a simple and didactic method was adopted. To this end a new food plan card was produced

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(copies available on request from the authors). The more complicated instruction commonly given to juvenile-onset diabetic patients was purposely avoided. The only measurement required by our patients was to weigh carbohydrate foods on a small dietary balance. Protein foods were allowed in moderation (estimated 60-90 g at each main meal) along with fibrous vegetables and a certain amount of fruit. The variable factors in each diet were the starch components, such as bread, potatoes, and plain biscuits. Milk was allowed in amounts varying from 300 ml to 600 ml a day. Fats and oils were permitted in moderation. The cholesterol or fibre content of the diet was not separately defined, and no suggestion for the use of polyunsaturated fats was made.

The patients were seen at monthly intervals for the first six months and thereafter at three-month intervals. Fasting plasma specimens (14-hour overnight fast) for glucose, triglyceride, and cholesterol were obtained at a separate attendance before each of these visits. As part of the design of the larger study a glucose tolerance test was carried out at diagnosis and after six months. At each of these two occasions the patients were instructed to eat a diet of 8.5 MJ (2033 kcal) for one week before the test. The fasting specimens reported at the start and six months are therefore after one week on an 8.5 MJ diet. The fasting specimens at 12, 24, and 36 months were taken while the patients were on the basic treatment diet.

The dietary progress of each patient was monitored at each visit, and the patients were graded on a 5-point subjective numerical scale (1-5) according to their adherence to the prescribed diet. The dietitian's rating was intended to be as reproducible and accurate as is possible with this type of grading procedure. The following criteria were used:

Grade 1—Really conscientious dietary adherence with considerable interest in the details of careful diet.

Grade 2—A good adequate knowledge of the food that was supposed to be eaten but with a few errors, not sufficient to make a real difference to energy intake.

Grade 3—Reasonable knowledge but with more manifest errors of dietary commission.

Grade 4—Knowledge of supposed diet clearly inadequate, with multiple errors in food intake.

Grade 5—No effort made to alter dietary habits at all, and all dietetic counsel ignored.

Results

Table I shows "mean" values for body weight, fasting plasma glucose and plasma cholesterol and triglyceride values at six-month intervals. The mean fasting plasma glucose concentration initially was 10.4 mmol/l (187 mg/100 ml) falling to 7.0 mmol/l (126 mg/100 ml) at six months. There was a slight but steady increase during the subsequent 30-month period. At no time did it fall below 7.0 mmol/l (normal range 3.5-5.0 mmol/l (63-90 mg/100 ml)). (It is recognised that interpretation of a mean value is dependent on normally distributed variables.) No patient complained of any symptoms of hyperglycaemia after establishing dietary management. After six months there was no further fall in the mean body weight, which remained just above the upper range of the average weight for a population of this age distribution. Mean plasma cholesterol concentration was normal at diagnosis and remained normal subsequently, but the initial hypertriglyceridaemia subsided and subsequently fluctuated around the upper limit of normal.

To assess the effect of dietary adherence on these measurements we have taken the mean numerical dietary rating for each patient from the scores recorded at 6, 12, 18, 24, 30, and 36 months. We have constructed three dietary adherence groups equivalent to "good" (1.00-1.99), "fair" (2.00-2.99), and "moderate" (3.00-3.99). The first group contained 19 patients, the second 25, and the third 12. Two

patients had a mean dietary rating of greater than 4.00 ("poor"). Table II shows that those patients who at the end of the study achieved an overall dietary adherence rating of less than 2.00 were less overweight at onset of their diabetes than those who were graded with higher dietary adherence ratings. All patients achieved a relatively similar proportionate weight loss, although those who were in the highest dietary rating remained the heaviest at the 36th month. Plasma glucose concentrations did not reflect the differences in estimated dietary adherence. All patients showed a similar fall in mean plasma glucose concentrations by 36 months regardless of their dietary adherence rate. Plasma cholesterol concentrations showed no apparent trend. The fasting plasma triglyceride concentrations appeared to follow the pattern of body weight more closely than that of blood sugar. Assuming that the method of dietary assessment was consistent over the three-year period 23 patients did not change (12 good, 5 fair, 5 moderate, and 1 poor), 22 moved to a less good grade (worse dietary adherence), and three to a better grade. There is a trend over the two-year period toward a less good dietary adherence for the whole group, but because of the small numbers it is not possible to apply a formal test of significance.

TABLE II—Comparison of mean values ($\pm$ SEM) for body weight (kg) and fasting plasma glucose, cholesterol, and triglyceride concentrations (mmol/l) at 0, 18, and 36 months: subdivided into three groups whose overall mean dietary rating during study was: good (1.00-1.99) 19 patients; fair (2.00-2.99) 25; and moderate (3.00-3.99) 12

	Dietary assessment	0 months	36 months	Average weight
Weight (kg)	Good	73.2 $\pm$ 2.4	66.3 $\pm$ 1.9	69.5 $\pm$ 1.5
	Fair	82.3 $\pm$ 2.7	73.1 $\pm$ 1.9	68.6 $\pm$ 1.4
	Moderate	89.4 $\pm$ 4.4	72.6 $\pm$ 3.3	70.3 $\pm$ 1.8
Fasting plasma glucose concentration (mmol/l)	Good	10.1 $\pm$ 0.7	7.3 $\pm$ 0.2	
	Fair	10.9 $\pm$ 0.8	7.3 $\pm$ 0.3	
	Moderate	10.0 $\pm$ 1.0	8.6 $\pm$ 1.2	
Fasting plasma cholesterol concentration (mmol/l)	Good	5.9 $\pm$ 0.3	6.5 $\pm$ 0.3	
	Fair	6.6 $\pm$ 0.3	6.5 $\pm$ 0.2	
	Moderate	5.9 $\pm$ 0.4	6.0 $\pm$ 0.5	
Fasting plasma triglyceride concentration (mmol/l)	Good	2.4 $\pm$ 0.5	1.3 $\pm$ 0.2	
	Fair	3.1 $\pm$ 0.6	1.8 $\pm$ 0.3	
	Moderate	2.1 $\pm$ 0.2	1.8 $\pm$ 0.2	

Formal analysis of variance of the four factors (weight, and plasma glucose, cholesterol, and triglyceride concentrations) for their degree of influence on the dietetic assessment at 12, 24, and 36 months showed that weight was always closely related to dietary assessment ($p < 0.01$ at all three times), but that the other three variables were not significantly associated with diet assessment.

Discussion

An earlier report on this study has shown that a large proportion of symptomatic maturity-onset diabetics can be satisfactorily controlled on diet without the need of oral hypoglycaemic agents or insulin.⁹ When those who were good or moderate dieters were assessed the latter were found to have consistently higher plasma insulin and plasma triglyceride values, although fasting blood sugar was not significantly higher. It was suggested that lack of dietary adherence might of itself be an important primary prognostic risk factor. It is clear from this subgroup followed for three years that overall weight loss can be maintained for a group of maturity-onset diabetics: the important benefit to those patients who can be considered good

TABLE I—Comparison of mean values ($\pm$ SEM) for body weight and fasting plasma glucose, cholesterol, and triglyceride concentrations (mmol/l) at onset and at six-monthly intervals up to 36 months. ($n = 58$ patients)

	No of months						
	0	6	12	18	24	30	36
Weight (kg)	81.0 $\pm$ 1.8	71.8 $\pm$ 1.4	71.3 $\pm$ 1.3	70.8 $\pm$ 1.3	71.1 $\pm$ 1.2	70.7 $\pm$ 1.2	70.8 $\pm$ 1.2
Fasting plasma glucose concentration (mmol/l)	10.4 $\pm$ 0.5	7.0 $\pm$ 0.3	7.1 $\pm$ 0.3	7.3 $\pm$ 0.2	7.5 $\pm$ 0.2	7.6 $\pm$ 0.3	7.6 $\pm$ 0.3
Fasting plasma cholesterol concentration (mmol/l)	6.2 $\pm$ 0.2	6.5 $\pm$ 0.2	6.2 $\pm$ 0.2	6.3 $\pm$ 0.2	6.4 $\pm$ 0.2	6.1 $\pm$ 0.2	6.4 $\pm$ 0.2
Fasting plasma triglyceride concentration (mmol/l)	2.6 $\pm$ 0.3	1.8 $\pm$ 0.1	1.5 $\pm$ 0.1	1.6 $\pm$ 0.1	1.9 $\pm$ 0.2	1.7 $\pm$ 0.1	1.6 $\pm$ 0.1

Conversion: SI to traditional units—Plasma glucose: 1 mmol/l $\approx$ 18 mg/100 ml. Plasma cholesterol: 1 mmol/l $\approx$ 38.5 mg/100 ml. Plasma triglyceride: 1 mmol/l $\approx$ 88.5 mg/100 ml.

dieters is that their fasting blood sugar and triglyceride values are lower than those who are graded as moderate dieters. How much the basic personality of the patient who is a moderate dieter plays a part in the likelihood of him becoming a maturity-onset diabetic (due to excess food intake) and how much a genetic defect underlies the disease¹³ is uncertain.

Fasting plasma glucose values above 7.8 mmol/l (140 mg/100 ml) have been shown to be only weakly associated with higher mortality among male survivors of a myocardial infarct.¹⁴ (There was also some evidence of increased mortality among users of oral hypoglycaemic agents in men with raised baseline plasma glucose values.) If hyperglycaemia, as well as obesity and hypertriglyceridaemia, can be controlled by reducing energy intake only, this will probably (though still not certainly) lower the ultimate incidence of myocardial infarction for the maturity-onset diabetic. The alternative of treatment with an oral hypoglycaemic agent, which will lower his plasma glucose value without the necessity of his reducing his energy intake to the same degree¹⁵ has not been shown to have any advantage.

The role of the clinical dietitian in this dietary management programme has been central. Although some advocates of dietary instruction¹⁶ have emphasised the more complex and advanced aspects of food science with elaborate lists of exchanges and formidable cookery books and recipes, we have always taken a basic and simple approach. To some extent this may reflect the attitudes of the population among whom we practise, but we suspect that human nature, particularly with regard to food, does not greatly differ in other places, and perhaps this explains the tendency for complex dietary regimens failing to control hyperglycaemia. We have been encouraged by the long-term success of our simplistic dietary approach, and find that the routine interview with the dietitian at each three-monthly appointment is a most important part of the follow-up and care of these patients. It is clear to us that the specialised knowledge of a therapeutic dietitian (albeit applied in a simplistic manner) is essential to the success of this programme, and that even physicians trained in diabetic management do not have the time or expertise to offer helpful routine food counselling at the diabetic clinic. With the present shortage of therapeutic dietitians it is not possible to offer their services other than at a centralised hospital diabetic clinic. Unless a dietetic service is available, the long-term care of maturity-onset diabetics in family practice has little meaning.

In a survey of dietary policy and management of British diabetic clinics Truswell *et al*⁸ were not able to obtain any exact data on the proportion of patients who adhered to their prescribed diet. They formed an impression that most doctors considered that most overweight maturity-onset diabetic patients did not keep to a diet, while those of average weight were thought to diet better. Studies where any attempt has been made to measure dietary intake are rare. In Japan Maruhama *et al*¹⁷ assessed food intake by similar means to our own, and also found that hypertriglyceridaemia was significantly related to excess food intake, even when plasma glucose concentration appeared to be well controlled by other means. Our own data would give numerical support to the general conclusion that weight loss, and fall in plasma glucose and plasma triglyceride values are more strongly significant for those graded as good or fair at dietary adherence. Those graded as only moderate (grade 3) at dietary adherence remained more overweight, showed a non-significant fall in blood sugar, and no fall in triglyceride concentration. These grade 3 dieters had been more overweight at onset of their diabetes.

Much effort is being devoted to evaluation of diabetes patient-education programmes in the USA. We do not necessarily subscribe to some of these suggestions¹⁸ and would enter a plea for simplicity of instruction, food planning, and assessment. We have not found any response to a "schoolroom" instruction approach, or to efforts to increase the patients' knowledge of dietary theory. We have focused on a rather didactic instruction by the dietitian with a simple food plan followed by reinforcement by the same doctor and dietitian at

each clinic visit. Whether this concept will yield any different long-term morbidity or mortality will require continued follow-up.

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What exactly is "resetting of the osmostat" diagnosed in some cases of hyponatraemia after prolonged courses of diuretics?

The osmostat is a physiological mechanism that maintains plasma osmolality constant at around 285 mmol (mosmol)/kg. Its anatomical components probably include the carotid body, hypothalamus, posterior pituitary, and kidney. If a normal subject drinks water plasma osmolality falls, antidiuretic hormone secretion is inhibited, and he passes dilute urine until plasma osmolality is restored to normal. If he is deprived of water antidiuretic hormone is secreted and he passes concentrated urine. In a few patients with various diseases these events occur when plasma osmolality diverges from an abnormally low value such as 250 mmol (mosmol)/kg; the osmostat is "reset" like a domestic thermostat in a fuel crisis. An example was recently described in the *BMJ*.¹ Such an event is unusual during diuretic treatment.² Most hypertensive patients taking diuretics with a free diet maintain normal plasma sodium concentration and have a normal osmostat. The mechanisms regulating plasma osmolality are probably sensitive to intracellular:extracellular gradients rather than absolute plasma osmolality. Resetting of the osmostat should arouse suspicion that the patient has intracellular electrolyte depletion, as may occur in cardiac failure.

¹ Penney MD, Murphy D, Walters G. Resetting of the osmoreceptor response as cause of hyponatraemia in acute idiopathic polyneuritis. *Br Med J* 1979;iii:1474-6.

² Ghose RR. Reset osmostat after diuretic treatment. *Br Med J* 1977;ii:1063.