

drop in systemic arterial pressure from 170/80 to 70/45 mm. Hg, recorded from a cannula in the brachial artery. The pulse rose from 54 to 78/min. When he lay down again all the parameters returned to normal, but once more the arterial pressure lagged behind right atrial pressure. Similar haemodynamic changes occurred with a tilt-table, and in no instance did alteration in posture induce any symptoms.

A convenient method of simulating the effects of postural change is to apply suction to the lower half of the body as described by Ardill *et al.* (1965). When a pressure of 44 mm. Hg below atmospheric was applied to this patient's body distal to the iliac crests, the systolic pressure fell to 55 mm. Hg, though no symptoms occurred. His circulatory adjustments to this manoeuvre will be reported in detail elsewhere (Bannister, Ardill, and Fentem, in preparation).

Exercise.—The response to exertion was studied by asking the patient to climb up and down a step at a rate equivalent to 500 kg.-m./min. for three minutes. When he rested his arterial pressure dropped from 90/40 to 45/25 mm. Hg. Right atrial pressure fell 12 mm. Hg, but the pulse showed little change. Within 10 seconds of stopping exercise the patient complained of the visual disturbance which had brought him to hospital. He was unsteady, but he did not lose consciousness. His symptoms cleared on lying down.

Valsalva's Manoeuvre.—This showed complete block of the vasomotor reflexes.

COMMENT

Orthostatic hypotension has become much commoner since the introduction of powerful hypotensive drugs and anti-depressants with hypotensive side-effects. Rarer causes include polyneuritis, tabes dorsalis, craniopharyngioma, and Addison's disease. Its association with Parkinsonism, as in this case, was described by Shy and Drager (1960). The incidence of orthostatic hypotension in old age is probably much higher than has previously been recognized, and this has been attributed to cerebrovascular disease (Johnson *et al.*, 1965).

Interest in the physiological defect has recently been focused on a more critical appraisal of venous tone (Bevegård *et al.*,

1962). In the patient described here changes in right atrial pressure preceded alterations in arterial pressure on lying and standing. This supports the view that a disturbance of venous tone may play an important role in the failure of arterial pressure.

Returning to the clinical features of this patient, it is notable that his symptoms occurred after taking exercise, and no discomfort could be induced by changes in posture. In 1907 Gordon found a fall of 25 mm. Hg in the systolic pressure of two healthy rugby players after an international match. With more sophisticated techniques, Holmgren (1956) recorded drops of 45 mm. Hg in four normal subjects after 2,500 kg.-m./min. on a bicycle ergometer. Presumably the fall is due to circulating vasodilators persisting after cessation of the reflex and mechanical factors which maintain arterial pressure during exercise. While a drop of 45 mm. Hg can be tolerated in a normal subject with a systolic pressure above 140 mm. Hg during exertion, in this patient the pressure during exercise ran at 90 mm. Hg, so the subsequent fall was disastrous.

I wish to thank Dr. C. J. Earl, Dr. Denis Williams, and Dr. Roger Bannister for their help. Dr. R. D. Bradley did the manometric recordings.

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mann *et al.*, 1965), and the details of the responses of one of these patients are here presented.

METHODS

The patient was treated as an out-patient in the dietetic kitchen of our metabolic unit while she pursued her normal daily activities. Food was prepared by trained dietitians and consisted of three meals served in the dietetic kitchen, and a small snack taken home by the patient to be eaten in the late evening. Unconsumed food was returned so that the daily caloric intake and composition of the food could be calculated. The patient was weighed daily.

The diets were prepared from natural foodstuffs, and were adjusted to the special needs and habits of the patient as much as possible. The composition of the various diets was calculated, using food composition tables (McCance and Widdowson, 1960; Guggenheim, 1964). During the experiments three almost isocaloric

Composition of Experimental Diets

Diet	Total Calories	Composition of Diet (% of Total Calories)			Composition of Carbohydrate (% of Total Carbohydrate)		
		Protein	Fat	Carbo-hydrate	Poly-saccharides	Sucrose	Unde-fined
Starch ..	2,720	21	4	75	91	0	9
Unsaturated fat ..	2,640	17	45*	38	87	0	13
Sucrose ..	2,620	15	2	83	13	79	8

* 91% of fat consisted of sunflower oil.

Effect of Starch and Sucrose on Carbohydrate-induced Hyperlipaemia*

Brit. med. J., 1966, **1**, 339-340

Essential hyperlipaemia has been subdivided by Ahrens into two entities, in one of which the hyperlipaemia is fat-induced and in the other carbohydrate-induced (Ahrens *et al.*, 1961). Of these the latter is the more common. In carbohydrate-induced hyperlipaemia most of the dietary carbohydrate is converted into triglycerides by the liver at an accelerated rate (Farquhar *et al.*, 1964). Recently it has been emphasized that the various dietary carbohydrates have different effects on human lipid metabolism. Thus Macdonald (Macdonald and Braithwaite, 1964) found in an isocaloric exchange of 550 g. per day of sucrose for maize starch in seven normal men that there was no change in serum lipids on maize starch, but that sucrose caused an increase in serum triglycerides. It was therefore of interest to study the effect of dietary starch and sucrose in patients with carbohydrate-induced and other types of hyperlipaemia. The marked responsiveness of the lipids of these patients to such diets has already been referred to (Kauf-

* Supported by a grant from the U.S. Department of Agriculture, PL 480 Research Project FG-Is-168.

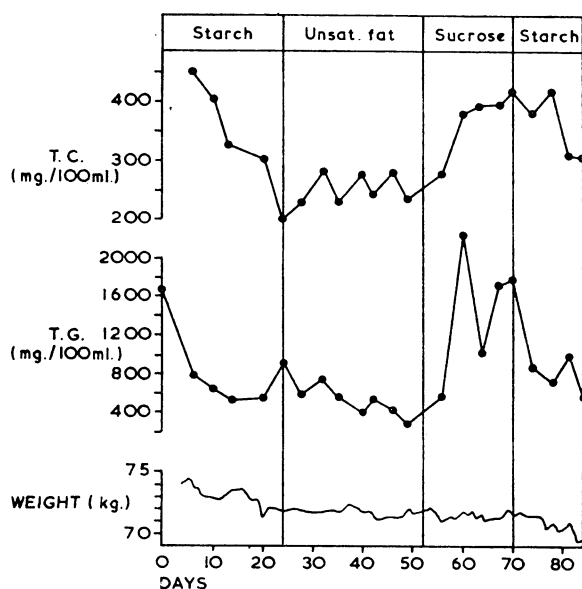
diets were fed (see Table). The polysaccharides of the "starch" diet were given in the form of bread, flour, cornflour, and potatoes. In the "sucrose" diet two-thirds of the sucrose was given in beverages and the remainder added to solid food and cakes. Sunflower oil was used in the "unsaturated fat" diet.

Serum triglyceride glycerol was determined by a modification of the method of Lambert and Neish (1950) after a selective extraction from serum (Shafir, to be published). Serum free fatty acids were determined by the method of Dole and Meinertz (1960) and lipoprotein-lipase activity of post-heparin plasma by the method of Fredrickson *et al.* (1963).

CASE REPORT

The patient, a 50-year-old Jewish woman, born in Rumania, was found to have a milky serum during a routine blood examination. Before the dietary experiment was started she was admitted to the metabolic unit for thorough clinical and laboratory evaluation. Her past history contributed nothing of importance, apart from mild hypertension for the preceding three years. She had suffered from repeated attacks of epigastric pain for one year, and radiographic examination suggested the possibility of a duodenal ulcer. On physical examination the blood-pressure was 160/90 mm. Hg, a grade II blowing systolic murmur was heard over the praecordium, and the liver was palpated at the costal margin. Urinalysis showed 1 plus albuminuria. Blood urea and the liver-function tests were normal. The serum-triglyceride level ranged between 1,670 and 2,700 mg./100 ml. and the total cholesterol between 450 and 636 mg./100 ml. The fasting blood-glucose level was 104 mg./100 ml., and in an oral glucose-tolerance test (1 g./kg. body weight) it reached 193 mg./100 ml. after one hour and returned to the fasting level after 2.5 hours. During the test the serum free fatty acids decreased from an initial level of 777 mEq/l. to 389 mEq/l. after 2.5 hours. Lipoprotein-lipase activity of post-heparin plasma was in the low normal range, 0.235 mEq/ml./min.

Before the dietary experiments started the level of serum triglyceride was 1,670 mg./100 ml. and the total cholesterol 450 mg./100 ml. When the starch diet was first fed for a period of 24 days the serum triglyceride and cholesterol fell gradually (see Fig.). The unsaturated fat diet was then fed for 27 days, and the serum triglyceride and cholesterol decreased further. The sucrose diet was then fed for 18 days, during which a sharp rise in serum triglyceride occurred; this reached a peak concentration of 2,170 mg./100 ml. after eight days, and then, after a brief decrease, remained between 1,730 and 1,820 mg./100 ml. During this period the serum cholesterol rose gradually to 425 mg./100 ml. When the starch diet was fed again for 14 days the triglyceride concentration decreased rapidly, while the total cholesterol remained elevated for a week but then decreased to 306 mg./100 ml.



Effect of various diets on serum triglycerides (T.G.) and total cholesterol (T.C.). Composition of diets given in Table.

COMMENT

The tendency for a carbohydrate-rich diet to raise serum-triglyceride concentrations has been well documented. Thus one-fifth of hypertensive patients fed on a Kempner rice and fruit diet, which also includes sucrose, showed an increase in serum neutral fats (Hatch *et al.*, 1955). In four subjects fed on a liquid formula with increasing amounts of carbohydrate—from 45 to 75% of total calories as dextrose monohydrate—Ahrens noted a prompt increase in serum triglycerides, which persisted during the four weeks of the experiment (Ahrens *et al.*, 1957). Decreasing the amount of carbohydrate and increasing the amount of corn-oil fed caused a rapid decrease in triglycerides to normal levels.

In long-term experiments on prisoners, Antonis and Bersohn (1961) found an increase in serum triglycerides when carbohydrates, the nature of which was not specified, were increased at the expense of fats. However, when the diet was continued for up to 32 weeks, the triglycerides decreased and returned to initial concentrations. In studies of the effect of dietary interchange of glucose, sucrose, and lactose on serum lipids Anderson *et al.* (1963) found the greatest increase in serum triglycerides when corn-oil was replaced by sucrose.

Among a group of supposedly normal volunteers for a study of the effect of the interchange of starch and sucrose on serum lipids and glucose tolerance a patient with hyperlipaemia was inadvertently included. On a relatively high starch diet (413 g. of bread daily) this subject's serum cholesterol and triglycerides decreased (Groen *et al.*, to be published) and his glucose tolerance improved (Cohen *et al.*, to be published). On a diet with 392 g. a day of sucrose the lipids increased and the glucose tolerance was impaired.

It would thus appear that in some cases of carbohydrate-induced lipaemia starch reduces both serum triglycerides and cholesterol and that in these cases the hyperlipaemia is, at least in part, sucrose-induced. This effect of sucrose in increasing serum lipids is of particular significance in view of the recent epidemiological data pointing to the aetiological importance of the prevailing type of dietary carbohydrate in diabetes and coronary heart disease (Yudkin, 1957; Cohen, 1963; Yudkin, 1963).

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