CONCENTRATIONS OF GLUCOSE, NON-ESTERIFIED FATTY ACID, AND INSULIN DURING ORAL GLUCOSE-TOLERANCE TESTS

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Bierman et al. (1957) have shown that the plasma concentration of non-esterified fatty acids (N.E.F.A.) may be increased in diabetes, and Dole (1956) and Gordon and Cherkes (1956) have shown a similar rise in normal people after dietary restriction of carbohydrate. Recent in-vitro studies have shown that many of the abnormalities of carbohydrate metabolism in muscle in diabetes and carbohydrate deprivation (including insensitivity to insulin) may be due to release of more fatty acids for oxidation (Randle, Garland, Hales, and Newsholme 1963). This suggested the possibility that release of more fatty acids might be an important cause of insulin insensitivity in diabetes and in people deprived of carbohydrate. This has led us to measure plasma concentrations of glucose. N.E.F.A., and insulin during glucose-tolerance tests in normal people on diets high or low in carbohydrate and in diabetic patients.

Methods

Tests on normal people.—Five normal men (ages 23–36), whose daily intake of carbohydrate was more than 200 g., were given 50 g. and 100 g. oral glucose-tolerance tests after an overnight fast. The same men had repeat 100 g. tests after five days on a diet containing less than 50 g. of carbohydrate daily (fat and protein unrestricted), and two further tests two and five weeks after returning to a high-carbohydrate intake.

Tests on diabetic patients.—All of the diabetic patients studied were under the care of physicians at Addenbrooke's Hospital, Cambridge. They had not been treated with diet, insulin, or oral hypoglycæmic agents (carbohydrate intake more than 180 g. per day). They were subjected to 50 g. oral glucose-tolerance tests after an overnight fast.

Plasma samples.—Blood from an antecubital vein was drawn into tubes containing solid heparin, and the plasma separated by centrifugation. Plasma glucose and plasma N.E.F.A. were assayed the same day. Samples for estimation of plasma insulin were stored at −12°C. In the investigation of normal people samples of blood were taken during fasting, and 30, 60, and 150 minutes after glucose administration. An additional sample

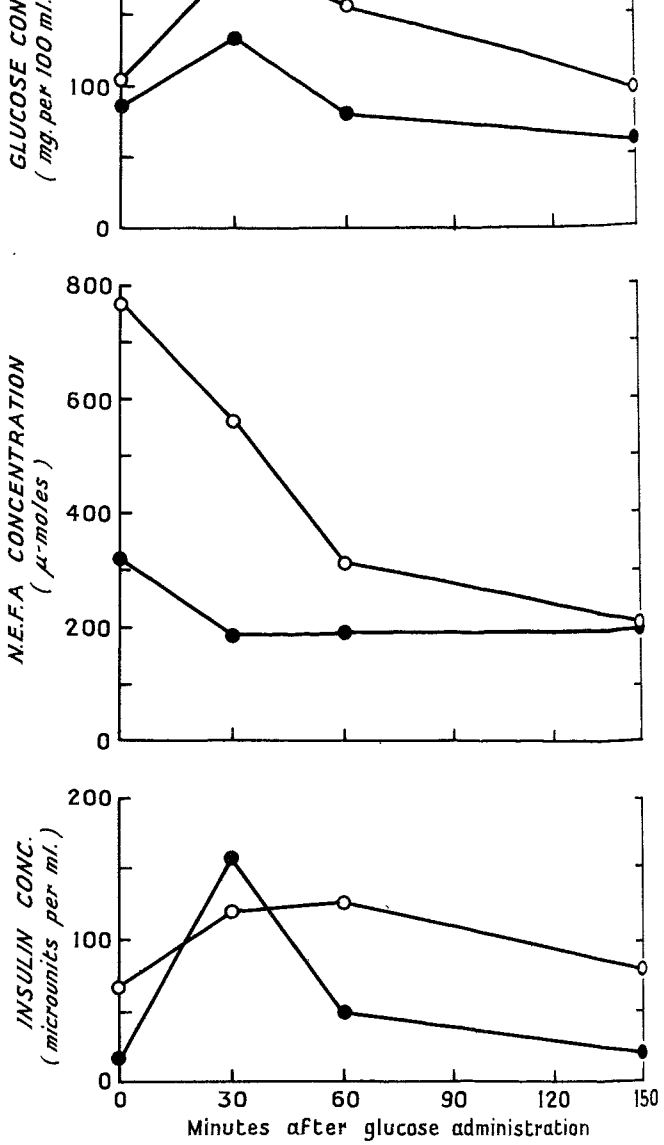

Fig. 1—Mean plasma concentrations of glucose, non-esterified fatty acid, and insulin during 100 g. oral glucose-tolerance tests performed before and during a low carbohydrate diet.
●——● Before diet. O——O During diet.

TABLE I—EFFECTS OF DIET AND DIABETES ON PLASMA CONCENTRATIONS OF GLUCOSE, N.E.F.A., AND INSULIN DURING ORAL GLUCOSE-TOLERANCE TESTS (G.T.T.)

Group	No. of people	Plasma concentration (mean and range) and time after glucose administration														
		Glucose (mg. per 100 ml.)					Non-esterified fatty acids (μ-moles)					Insulin (microunits per ml.)				
		0 min.	30 min.	60 min.	90 min.	150 min.	0 min.	30 min.	60 min.	90 min.	150 min.	0 min.	30 min.	60 min.	90 min.	150 min.
Normal people																
50 g. G.T.T.	5	89 (85-96)	126 (97-142)	94 (69-116)	..	78 (67-87)	350 (260-440)	220 (150-300)	210 (130-300)	..	394 (190-590)	16 (6-25)	64 (35-88)	65 (43-120)	..	22 (6-37)
100 g. G.T.T. ..	5	86 (80-98)	134 (106-160)	80 (65-102)	..	61 (36-74)	320 (270-380)	184 (130-220)	190 (140-270)	..	200 (160-270)	17 (10-27)	158 (45-320)	49 (20-100)	..	21 (6-27)
Low carbohydrate diet; 100 g. G.T.T. ..	5	105 (102-112)	188 (173-198)	157 (122-217)	..	97 (74-140)	768 (340-1200)	563 (330-770)	312 (260-400)	..	206 (110-320)	67 (52-80)	120 (100-140)	126 (90-160)	..	79 (50-110)
14 days later; 100 g. G.T.T.	5	93 (85-103)	129 (119-150)	98 (82-110)	..	83 (60-103)	438 (190-660)	246 (140-410)	192 (110-380)	..	142 (50-330)	42 (30-58)	120 (80-170)	99 (66-124)	..	64 (46-76)
35 days later; 100 g. G.T.T.	5	91 (81-100)	131 (112-148)	94 (76-110)	..	69 (59-77)	394 (350-550)	326 (220-500)	220 (160-250)	..	222 (140-430	21 (10-40)	117 (66-190)	101 (48-190)	..	29 (16-42)
Diabetics																
Group I: 50 g. G.T.T.	3	98	148	161	150	100	640	500	370	280	240	14	88	82	70	42
Group II: 50 g. G.T.T.	9	136	200	234	235	163	580	490	420	270	290	45	59	78	71	47
Group III: 50 g. G.T.T.	10	233	311	373	383	339	900	750	690	560	630	41	42	54	53	43
Ketotic diabetics: 50 g. G.T.T.	4	424					1600					25				