Plasma insulin and free fatty acids as risk factors for arterial compliance in Type-2 diabetes

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Introduction

Non-invasive techniques using Doppler ultrasound to study arterial wall compliance are harmless, simple to perform and reproducible[1,2]. Relf *et al.*[3] have reported that arterial compliance is significantly and negatively correlated with age, blood pressure, serum total cholesterol and serum triglyceride and also signific ntly and positively correlated with serum HDL-cholesterol in healthy men. However, the correlation between arterial compliance and other risk factors is unknown. The present study was undertaken to investigate the relationships between arterial compliance and two possible risk factors, plasma free-fatty-acids and insulin, in Type 2 (non-insulin-dependent) diabetes.

Subjects and methods

Thirty eight healthy subjects (ten men and 28 women) and 27 (13 men and 14 women) type II diabetics, matched for age, height and weight, were studied. None of the subjects were smokers or hypertensive. No subject had any symptoms or past history of arterial disease. All had normal ankle pressure indices as measured by Doppler ultrasound.

Each subject was rested supine for ten minutes to allow the blood pressure to stabilise. Two 4 MHz Sonicaid Doppler ultrasound units were used. The probes were placed over the left subclavian artery in the supraclavicular fossa and over each common femoral artery at the inguinal ligament in turn. The two signals obtained were passed through a Medishield spectrum analyser and displayed on light-sensitive paper. The time delay between the start of the proximal and the distal pulse waves was calculated from the mean of ten pulses from each side. The pulse wave velocity (PWV) down the aorta and iliac segments was calculated from the ratio of time delay, t (sec), and the measured distances between the probe, l (m)[1,4]:

$$PWV = \frac{l}{t}\ m.sec^{-1}$$

$$C = \frac{66.7}{(PWV)^2}$$, where C is arterial compliance

Fasting blood was collected in each subject. Immediately after collection, a 75 g oral glucose load was given and hourly blood samples were collected for the next two hours.

All blood samples were estimated for glucose and free fatty acid concentrations and insulin immunoreactivity.

A colorimetric method was used for plasma free fatty acid (FFA) determination[5]. A radio-immunoassay method was used for plasma insulin determination[6]. Statistical comparison of the groups were made on the basis of Student's t-test and the relationships were examined by correlation analysis.

Results and discussion

Characteristics for both healthy subjects and Type 2 diabetics are shown in Table 1.

Table 1. Characteristics of healthy subjects and Type-2 diabetics. The healthy and type 2 diabetic subjects did not differ significantly ($P < 0.05$)

Subjects	*n*	*Sex*	*Age*	*Stature (cm)*	*Body weight (kg)*	*BMI*	*BP*
Healthy	10	m	62 ± 5	171 ± 2	77 ± 4	26 ± 1	98 ± 3
Diabetic	13	m	61 ± 3	170 ± 2	79 ± 4	27 ± 1	98 ± 2
Healthy	28	f	69 ± 2	157 ± 1	66 ± 3	27 ± 1	95 ± 4
Diabetic	14	f	69 ± 2	157 ± 2	70 ± 3	28 ± 1	98 ± 2

Table 2. The arterial compliance, plasma free fatty acids, insulin and blood glucose of healthy subjects and Type 2 diabetics (mean ± s.e.)

Male

Subjects	*n*	*Arterial compliance*	*Glucose*		*Free fatty acid*		*Insulin*	
			Fasting μmol/l	*Area μmol/l/h*	*Fasting μmol/l*	*Area μmol/l/h*	*Fasting μU/ml*	*Area μU/ml/h*
Healthy	10	1.02 ± 0.07	5.2 ± 0.2	13.7 ± 1.0	329 ± 32	357 ± 41	10.5 ± 1.0	117 ± 23
Diabetics	13	0.55 ± 0.06	10.3 ± 1.0	30.2 ± 2.2	424 ± 30	647 ± 51	20.6 ± 2.8	136 ± 23
P		< 0.001	< 0.001	< 0.001	< 0.05	< 0.001	< 0.01	n.s.

Female

Subjects	*n*	*Arterial compliance*	*Glucose*		*Free fatty acid*		*Insulin*	
			Fasting μmol/l	*Area μmol/l/h*	*Fasting μmol/l*	*Area μmol/l/h*	*Fasting μU/ml*	*Area μU/ml/h*
Healthy	28	0.89 ± 0.05	5.3 ± 0.1	15.6 ± 0.5	353 ± 17	415 ± 22	9.4 ± 0.9	109 ± 12
Diabetics	14	0.56 ± 0.03	10.1 ± 1.1	34.1 ± 2.9	461 ± 36	681 ± 59	22.5 ± 2.6	155 ± 26
P		< 0.001	< 0.001	< 0.001	< 0.01	< 0.001	< 0.001	< 0.05

The arterial compliance was significantly less in Type-2 diabetics compared with healthy subjects, for both men and women (Table 2).

The fasting plasma free fatty acid and free-fatty-acid area were significantly higher in Type-2 diabetics compared with healthy subjects, for both men and women (Table 2).

There was a significant increase in the fasting plasma insulin in Type-2 diabetics compared with healthy subjects, for both men and women (Table 2).

Arterial compliance was significantly and negatively correlated with blood glucose, plasma FFA and plasma insulin immunoreactivity (Table 3). Observations on healthy subjects and Type-2 diabetics have been pooled so as to allow compliance to be correlated with a wide spectrum of glucose, FFA and insulin values. There was a lack of significant correlation for diabetics alone which presumably reflects both smaller numbers of subjects and a restricted range of analytical values.

Table 3. The correlation (r) between arterial compliance and plasma free fatty acid insulin for healthy subjects and type 2 diabetics combined.

	Glucose		*Free fatty acid*		*Insulin*	
	Fasting	*Area*	*Fasting*	*Area*	*Fasting*	*Area*
r	−0.46	−0.52	−0.31	−0.50	−0.39	−0.26
n	65	65	65	65	65	65
P	< 0.001	< 0.001	< 0.05	< 0.01	< 0.01	< 0.05

It should be emphasized that this study has, by design, minimized the effect of other potential risk factors, such as age, obesity, blood pressure and smoking on compliance. Nevertheless, multivariate analyses of the data are desirable and will be presented elsewhere.

That FFA might be a risk factor for arterial wall change is of particular interest in the light of studies of atherogenesis. FFA can be incorporated into cholesterol ester in atherosclerotic lesions[7]. We cannot, however, say that measurement of arterial compliance in this study necessarily reflects atherosclerosis. For insulin, epidemiological evidence points to it as a risk factor for coronary arterial disease[8-10] and there is experimental evidence that it influences atherogenesis[11].

Summary

The study showed a significant difference in arterial compliance, plasma free fatty acids and plasma insulin between healthy subjects and Type-2 diabetics. The study also showed a significant correlation between the arterial compliance and plasma free fatty acid and plasma insulin concentration combining the healthy subjects and Type-2 diabetics. These results indicate that plasma insulin and free fatty acid are risk factors for changes in arterial wall characteristics at a stage when no clinical evidence of macrovascular disease is apparent.

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Protein energy malnutrition in patients undergoing regular haemodialysis

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Several investigators overseas, have reported protein energy malnutrition amongst patients on regular haemodialysis. Our observations suggested that similar nutritional abnormalities were occurring in our haemodialysis population. We therefore assessed the protein and energy nutrition in a sample of 50 patients (28 men: 22 women). Half the patients dialysed at home (for 16 to 18 hours per week) and the remaining half were dialysed at the hospital (for 11 to 12 hours per week). The dialysate was glucose-free. The measurements performed included weight, height, triceps skinfold, mid-upper arm circumference, selected plasma proteins and a lymphocyte count. Patients were asked to keep a 3-day food diary (60% completed this successfully). Twenty-eight per cent of patients had a Body Mass Index below 20 and an upper arm fat area less than the 5th percentile[1]. Thirty-two

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