

PRELIMINARY COMMUNICATIONS

Blood Viscosity in Diabetic Children

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Summary. The whole blood viscosity in diabetic children compared with normal adult controls is slightly increased when the blood sugar is increased. The increase is independent of the haematocrit, and is probably caused by factors in the plasma and not in the erythrocytes. Whether or not these findings are of clinical significance will be shown by a longitudinal study of these patients.

Viscosité du sang chez des enfants diabétiques

Résumé. La viscosité du sang total chez des enfants diabétiques est légèrement augmentée, par rapport à des témoins normaux adultes, quand la glycémie est augmentée. L'augmentation est indépendante de l'hématocrite et est probablement due à des facteurs situés dans le plasma et non dans les érythrocytes. Une étude de longue

durée de ces patients montrerait si ces résultats ont une signification clinique ou non.

Blutviskosität bei diabetischen Kindern

Zusammenfassung. Die gesamte Blutviskosität ist bei diabetischen Kindern, verglichen mit normalen, erwachsenen Kontrollpersonen leicht erhöht, wenn der Blutzucker erhöht ist. Die Erhöhung ist vom Hämatokrit unabhängig und wird wahrscheinlich von Plasmafaktoren und nicht von den Erythrozyten verursacht. Ob diese Befunde klinische Bedeutung haben oder nicht, wird sich bei Longitudinalstudien dieser Patienten zeigen.

Key words: Diabetes mellitus, juvenile diabetes, blood viscosity.

Diabetes is an important epidemiological factor in cardiovascular disease, but the pathogenesis of the angiopathy is unknown. Some workers have investigated the relationship between haemorrhology and diabetic angiopathy [2, 5]. At the Hospital for Sick Children, Toronto, we have begun a continuing study of the relationship of haemorrhological findings in diabetic children to the complications of diabetes. In this paper we report the initial blood viscosity data obtained.

Methods

The children, aged 3 to 16 years, were examined in the diabetic outpatient clinic and admitted to hospital when required. Blood samples were obtained by venipuncture at the same time as the sample for the fasting blood sugar determination (FBS) was taken. No data on blood viscosity in normal children are available yet, so for controls we used laboratory personnel and medical students in good health. Heparin powder was added to the blood, and the viscosity was determined at 37° with a Wells-Brookfield microviscometer, using five rotational speeds corresponding to shear rates of 230, 115, 46, 23 and 11.5 sec⁻¹ [7]. Microhaematocrit values were determined and the blood sugar was measured in the clinical laboratory by an automated (Auto-Analyzer) modification of Hoffman's method [3].

Blood viscosity is directly related to the haematocrit. The paired determinations of viscosity and haematocrit were grouped according to FBS, Group I < 100 mg%, Group II between 100 and 200 mg%, Group III between 200 and 300 mg% and Group IV over 300 mg%. These groups were subdivided by shear rate at 230 sec⁻¹, 115 sec⁻¹, 40 sec⁻¹, 23 sec⁻¹ and 11.5 sec⁻¹. The mean haematocrit and mean viscosity were determined for each of Groups I to IV at each shear rate. The most important determinant of blood viscosity is haematocrit. By grouping the data this way the haematocrit means differ from group to group, so to compare mean viscosities for each group haematocrit dependent differences must be eliminated. We used analysis of covariance [6] for this purpose, which allows direct comparison of viscosity means independent of the effect of haematocrit. Any significant differences are then the result of factors other than haematocrit. The 95% level of confidence was chosen as the level of significance for this study (Table 1).

Results

The results obtained in the four subgroups were compared with those obtained in the control group. The number of patients in each group, the mean haematocrit, the mean viscosities at different shear rates, and an indication of significance is presented in Table 1.

There is no difference in adjusted blood viscosity between Group I and the control group. The viscosities at the 2 lowest shear rates are higher in diabetic patients of Group II than in the control group. In Group III and IV the viscosities are higher at 3 and at 4 shear rates respectively than in the control group.

Table 1. Mean haematocrit and blood viscosity values obtained in 45 controls and in 76 diabetic children. The number of observations in each group is indicated in brackets. The statistical significance of the difference between each subgroup and the control group is indicated in the last column.

Group	Haemato- crit ± S.D.	Viscosity ± S.D. (cp.) Shear Rate (sec ⁻¹)	p value	
Control (45)	46.4 ± 3.7	230	4.5 ± 0.5	
		115	5.0 ± 0.5	
		46	6.0 ± 0.8	
		23	7.5 ± 1.0	
		11.5	9.1 ± 1.5	
Diabetes I (5)	42.2 ± 3.8	230	4.1 ± 0.5	n.s.
		115	4.6 ± 0.5	n.s.
		46	5.3 ± 0.7	n.s.
		23	6.7 ± 1.1	n.s.
		11.5	8.4 ± 2.1	n.s.
Diabetes II (22)	43.7 ± 2.6	230	4.3 ± 0.4	n.s.
		115	4.8 ± 0.4	n.s.
		46	5.8 ± 0.5	n.s.
		23	7.5 ± 1.1	<0.05
		11.5	9.4 ± 1.6	<0.05
Diabetes III (34)	44.2 ± 2.6	230	4.5 ± 0.4	<0.05
		115	4.9 ± 0.4	n.s.
		46	5.7 ± 0.4	n.s.
		23	7.6 ± 1.1	<0.05
		11.5	9.5 ± 1.3	<0.05
Diabetes IV (15)	45.6 ± 3.6	230	4.6 ± 0.5	<0.05
		115	5.1 ± 0.6	n.s.
		46	6.3 ± 0.8	<0.05
		23	8.3 ± 1.5	<0.05
		11.5	10.5 ± 1.6	<0.05

Discussion

These findings confirm the observation in adults that in patients suffering from diabetes mellitus, compared with controls, there is a slight increase in blood viscosity independent of the haematocrit. We found similar changes in burned patients [9]. Both in burned patients and in diabetics [1] the plasma fibrinogen is increased and this high fibrinogen concentration may explain the increased blood viscosity [8] rather than factors located in erythrocytes.

The blood viscosity is also related to the osmolarity of the surrounding medium [4]. The observation that

viscosity increased as the level of blood sugar increases suggests this mechanism as a possible explanation.

The incidence of cardiovascular disease is high in diabetics. Blood viscosity is increased when the blood sugar is increased. Even a small increase present over many years may influence blood flow and the interaction between blood and blood vessel wall. A longitudinal study of blood viscosity in diabetics may provide evidence for or against this hypothesis.

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