

The Relationship Between Blood Pressure and Blood Viscosity

Increasing evidence supports the importance of hemodynamic forces that are directly related to the work of the heart as the primary triggering event of atherosclerosis and atherothrombosis. The factors that primarily determine the work of the heart include systolic blood pressure (BP), blood viscosity, and the volume of blood the myocardium has to pump.

The relationship between BP and viscosity is such that, given a constant systolic BP, if blood viscosity increases, then the total peripheral resistance (TPR) will necessarily increase, thereby reducing blood flow. Conversely, when viscosity decreases, blood flow and perfusion will increase. Because of the dependence of systemic arterial BP on cardiac output and TPR, if blood viscosity and TPR rise, systolic BP must then increase for cardiac output to be maintained. Consequently, blood viscosity has been established as a major determinant of the work of the heart and tissue perfusion [1]. Since increased viscosity requires a higher BP to ensure the same circulating volume of blood, both the burden on the heart and the forces acting on the vessel wall are directly modulated by changes in blood viscosity.

Three important studies helped establish the relationship between blood pressure and blood viscosity. The earliest study observed 49 normal subjects and 49 patients with untreated essential hypertension, showing a direct correlation between BP and blood viscosity among both normotensive and hypertensive subjects ($p < 0.001$). Systolic blood viscosity was 8 to 10% higher in hypertensive patients compared with normotensive controls, and diastolic blood viscosity was 16 to 28% higher in hypertensive patients. Subgroups each comprised of 25 subjects having matched hematocrits were also compared, and viscosity remained significantly higher in hypertensive subjects ($p < 0.05$). [2]

In the Edinburgh Artery Study, which followed 1,592 randomly selected adults, demonstrated that systolic BP was univariately related to blood viscosity in males only ($p < 0.001$), and diastolic BP was univariately related to blood viscosity in both sexes ($p < 0.001$). Hematocrit-corrected blood viscosity levels were also significantly related to systolic and diastolic BP in both sexes. The study's authors suggested that the strong, independent relationship between viscosity and BP cannot be explained by hematocrit and plasma content alone, but erythrocyte deformability and fibrinogen made contributions. Moreover, they wrote that the pathophysiological significance of blood viscosity in hypertension related to its modulation of TPR. [3]

A third study followed 331 males newly diagnosed with essential hypertension for up to 12 years. The researchers grouped patients into three categories by their diastolic blood viscosity levels: high, medium and low. The highest tertile for diastolic viscosity were more than three times as likely to have cardiovascular events than the lowest diastolic viscosity tertile (hazard ratio = 3.42, 95% confidence interval = 1.40-8.38, $p = 0.006$).

The third study's authors concluded that both blood viscosity and hematocrit were univariate predictors of cardiovascular morbidity in hypertensive men but only viscosity came out as an independent risk factor in a multivariate analysis, thus supporting the perspective that diastolic blood viscosity "as a global marker of the whole-blood rheological properties may be a better discriminant of cardiovascular risk in hypertensive men." They added that blood viscosity, an overall measure of flow resistance of bulk blood,

depends on several factors, including cell concentration, cell aggregation, cell deformability and plasma protein concentration.

Blood viscosity holds certain similarities with blood pressure. Like blood pressure, the viscosity of blood changes during each cardiac cycle and is reported using two numerical quantities: systolic and diastolic viscosity. However, while blood pressure is parameter of the circulatory system as a whole, blood viscosity is a parameter specific to the fluid flowing through the system. Therefore, viscosity can be said to precede pressure and to be biophysically more fundamental than pressure.

Important Information

The Blood Viscosity Test is performed at Meridian Valley Lab using a calibrated glass capillary system that is classified as a Class I device under 21 CFR § 862.2920. The Blood Viscosity Test is not covered by insurance plans. Doctors must bill their patients or their patients' caregivers for this service.

References

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3. Fowkes FG, Lowe GD, et al. The relationship between blood viscosity and blood pressure in a random sample of the population aged 55 to 74 years. *Eur Heart J.* 1993;14:597-601
4. Ciuffetti G, Schillaci G, et al. Prognostic impact of low-shear whole blood viscosity in hypertensive men. *Eur J Clin Invest.* 2005;35:93-8

