Table 7: The relationship between yield velocity, whole blood viscosity and shear stress of phases 1 and 2 when erythrocyte concentration is 28%.

Yield velocity (m^{-1})	Blood viscosity μ_2 ($mNcm^{-2}$)	Shear stress corresponding to f_1, τ_1 10^3 (N/m^2)	Shear stress corresponding to f_2, τ_1 10^3 (N/m^2)
0.2	39	0.17	2.1
0.5	36.2	0.43	5.06
1	25.5	0.864	7.14
5	14.78	4.32	20.58

injury is made early. Future research should identify a set of the most important risk factors, which will help physicians to prevent mortality from aortic injury in emergency room settings.

This study is the first to attempt to identify the "internal" or "intrinsic" risk factors that may predispose an individual to aortic rupture. This study has determined that the shear stresses caused by plasma and erythrocytes differ significantly: the shear stress caused by erythrocytes is much higher than the stress created by plasma. Therefore, the impact of the shear stress caused by the second phase (erythrocytes) may be more significant than the impact of the first phase (plasma).

As noted in previous research, blunt injury to the vascular wall may result in the formation of rouleaux [21]. Therefore, the impact of the shear stress caused by the second phase may become particular prominent in trauma patients. However, the impact of the shear stress created by rouleaux is even greater then that of the shear stress from erythrocytes because of the size differences. Therefore, in trauma patients, the risk of aortic rupture is related to geometric peculiarities such as geometry of the vessel (the Dean number) and the extent of rouleaux formation. This may provide insights into the delayed rupture of the branching part of the vessels in the posttraumatic period (Table 18). According to this research, rouleaux formation due to trauma may lead to increased shear stress. Even if this increase is only 1.5-2-fold in a straight vessel, it is 4 times greater on the internal part of the vessel. Therefore, in some parts of the vascular system, the shear stress may increase up to 120 – 140 N/m^2 (a shear stress of 40 N/m^2 or more can damage the endothelium of the vessel, as mentioned earlier).

In general, substantial variations in the geometric parameters of human arteries have been recognized as knowledge of the geometric peculiarities of coronary vessels has advanced, perhaps because of their clinical significance [40-42]. In a study by Hutchins et al. [41], the range of angles in 56 coronary artery branches was shown to vary from 32 to 124 degrees. Both in vitro [43] and in vivo [44] studies have revealed substantial variation in arterial geometry at human aortic bifurcations. Arterial geometry has been suggested to play the role in hemodynamics and atherosclerosis [45]. Friedman et al. [46] suggested that various geometrical configurations of the vessel may result in different distributions of mechanical stress in the wall.

Our experience shows that various types of trauma may result in such serious outcomes as acute myocardial infarction [20,21,49,51,52]. Recognition of the fact that certain geometrical peculiarities in coronary arteries may predispose them to delayed rupture trauma may become important not only for identifying screening and treatment procedures to prevent further myocardial damage from trauma, but also to prevent further complications such as ventricular fibrillation. This is particularly important since acute myocardial infarction resulting from trauma has been shown to occur several hours or days after the trauma [19,49-52] (Table 18).

On the other hand, in some studies, pelvic and intra-abdominal injuries have been shown to be significantly associated with aortic injury. At the same time, there is no consensus about the capacity of seatbelt use to protect from such types of injury. The knowledge that certain geometric and rheological peculiarities may predispose a particular person to the impact of traumatic injury may help

Table 8: The relationship between yield velocity, whole blood viscosity and shear stress of phases 1 and 2 when erythrocyte concentration is 35.9%.

Yield velocity (m^{-1})	Blood viscosity μ_2 ($mNcm^{-2}$)	Shear stress corresponding to f_1, τ_1 10^3 (N/m^2)	Shear stress corresponding to f_2, τ_1 10^3 (N/m^2)
0.2	78.47	0.15	5.6
0.5	47.88	0.38	8.46
1	36.77	0.76	12.9
5	20.88	3.84	36