

## The Changes of Whole Blood Viscosity at Low Shear Rates Correlate with Intravascular Volume Changes During Hemodialysis

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Elevated blood viscosity was shown to be independently correlated with cardiovascular risk factors and associated with increased risk of major cardiovascular events, including death and acute myocardial infarction. The endothelial cell dysfunction has been reported in the patient with hemodialysis and it has been demonstrated that wall shear stress in low shear rate (around  $1 \text{ s}^{-1}$ ) is associated with vascular endothelial cell injury. The aim of the present study was to investigate changes in whole blood viscosity (WBV) at shear rates of  $1 \text{ s}^{-1}$  (low-shear blood viscosity) and  $300 \text{ s}^{-1}$  (high-shear blood viscosity) before and after hemodialysis in patients with end-stage renal disease (ESRD). We also examined the relationship between the changes of WBV and intravascular blood volume. Methods: Forty three patients with ESRD receiving maintenance hemodialysis were enrolled. Systolic and diastolic WBV was measured using a scanning capillary tube viscometer pre and post-dialysis to quantify dialytic viscosity surges. Body weight, blood pressure, and hematocrit were measured before and after hemodialysis as was the fluid removed during hemodialysis. Intravascular blood volume changes were calculated using hematocrit changes during hemodialysis and the height and body weight of a patient.

Low-shear blood viscosity at shear rate  $1 \text{ s}^{-1}$  after hemodialysis were higher than those before hemodialysis. The changes of low-shear blood viscosity have a 3 times greater impact on high-shear blood viscosity at shear rates of  $300 \text{ s}^{-1}$  during hemodialysis (15.9% in high-shear blood viscosity and 44.1% in low-shear blood viscosity, respectively). There was positive correlation between the percent changes of high-shear blood viscosity and the percent changes of low-shear blood viscosity. The changes of low-shear blood viscosity was significantly correlation with that of hematocrit during hemodialysis. The intravascular blood volume reduction calculated from hematocrits measured before and after hemodialysis was positively correlated with the changes of high-shear blood viscosity or low-shear blood viscosity.

The changes of diastolic WBV was about 3 times higher than that of systolic WBV and diastolic and systolic WBV changes correlated with intravascular volume changes during hemodialysis. These results suggest that the WBV parameter may hold additional information beyond hemoconcentration. Further research is needed to evaluate the relationship be

**Key Words:** 혈액투석, 혈액점도, 혈색소, 체중변화

Hemodialysis, Whole blood viscosity, Hematocrit, Fluid removal