S24: Clinical Studies in Hemorheology

S24-1 The role of hemorheologic changes in diabetic microvascular complications

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The prevalence of type 2 diabetes mellitus (T2DM) is increasing worldwide. In Korea, the prevalence of diabetes in those aged 30 years and over is estimated as 13.7% (4.8 million) and in those over 65 years of age as 30%. Diabetic micro- and macro-vascular complications are a major cause of mortality in T2DM patients. Micro-vascular complications, especially DKD, can be a risk factor for macro-vascular complications such as atherosclerosis, myocardial infarction, stroke, and heart failure. Therefore, the effort to screen for micro-vascular complications, including DKD, is essential to prevent the progression to macro-vascular complications and a deterioration in the quality of life.

Critical shear stress (CSS, mPa) is an index of red blood cell (RBC) aggregability, defined as the minimal shear stress required to disperse RBC aggregates. This study aimed to investigate the association between CSS and the risk of diabetic kidney disease (DKD). A total of 421 (mean age, 58.1 ± 11.5 years; male, 250) individuals with T2DM were enrolled and divided into three groups according to CSS level. CSS was measured using a transient microfluidic technique. DKD was defined as a glomerular filtration rate (GFR) <60 ml/min/1.73 m2 or a urine albumin-to-creatinine ratio (uACR) ≥ 30 mg/g. CSS was significantly higher in patients with DKD than in those without (317.43 ± 125.11 vs 385.22 ± 182.89, $p < 0.001$). Compared to the lowest CSS tertile, the highest CSS tertile was independently associated with the risk of DKD after adjusting for age, sex, duration of diabetes, presence of hypertension and haemoglobin. The cut-off value of CSS for DKD was approximately 310 mPa. These results suggest that haemorheologic changes may contribute to DKD, and further prospective studies are warranted to determine the role of CSS as a DKD screening tool.

S24-2 RBC abnormalities presented with clinical diagnostic variables in sepsis

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Sepsis and septic shock are medical emergencies and early detection, antibiotics administration and hemodynamic managements are closely associated with mortality. In clinical and experimental sepsis, red blood cell (RBC) abnormalities has been reported. However, it is not known how early RBC abnormalities are expressed compared to the various clinical manifestations used in the sepsis related organ failure assessment (SOFA). Therefore, we investigated whether RBC abnormalities has any clinical significance as an early indicator for detecting septic induced injury comparing with various clinical variables used on SOFA in endotoxin induced sepsis model.

Six-week-old male Sprague-Dawley rats received LPS (20 mg/kg) intraperitoneally. Aggregation indices (AIs) and aggregation half time (T1/2), elongation indices (EI max) were measured for assessing RBC aggregation and deformability. Clinical data related SOFA and lactate, venous-to-

arterial carbon dioxide difference/arterial- venous oxygen difference ratio [$P(v-a)CO_2/C(a-v)O_2$] were measured 2hr, 4hr, 8hr and 12 hr after LPS injection.

 AIs increased significantly 4 hr, 8hr, and 12 hr after LPS injection and T1/2 decreased significantly in LPS 2 hr, 8hr, and 12 hr after LPS injection. Platelet significantly decresed 4 hr, 8hr, and 12 hr after LPS injection. latate significantly increased 2 hr, 4hr, and 8 hr after LPS injection. AIs has statistically significant correlations with T1/2, platelet, bilirubin, creatinine, and $P(v-a)CO_2/C(a-v)O_2$. EI max increased significantly 2 hr, 4hr, and 8 hr after LPS injection, however, EI max had no significant correlation with any other variables.

 RBC aggregation seems to be early presented with clinical data deterioration in sepsis and may be helpful diagnostic indicator of septic injury.

S24-3 Decrease myocardial perfusion associated with hemorheologic parameters in patients with type 2 Diabetes

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Myocardial ischemia may be present even when there is no significant stenosis of the epicardial coronary artery, or after coronary angioplasty for significant coronary artery disease. This phenomenon is related to disturbance of the coronary microcirculation or vasomotor tone. The aim of this study was to determine the influence of clinical and RBC hemorheological factors on myocardial perfusion in patients with type 2 diabetes mellitus (DM) when compared to patients without DM, presenting with stable angina or acute coronary syndrome. Myocardial perfusion was graded using the myocardial blush grade (MBG) which describes the relative "blush" or intensity of the radio-opacity of myocardial tissue during coronary angiography. MBG was counted before any medical or mechanical intervention, and in the myocardial territory without anatomical flow limitation (<50% of luminal narrowing on coronary angiogram). Myocardial perfusion in this region was associated with DM, renal function, LV diastolic function, inflammatory biomarkers, but not with the clinical presentation. Among the hemorheological parameters, reduced myocardial perfusion was linked to increased RBC aggregation, but not to variation in RBC deformability. In conclusion, myocardial perfusion was affected by DM, LV diastolic function, and inflammatory activity indicated by clinical parameters, and by the hemorheological factor RBC aggregation.

S24-4 Erythrocyte aggregation and deformability as factors determining capillary blood flow in patients with arterial hypertension

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Erythrocyte reversible aggregation and deformability are the major properties that affect blood microcirculation. Alterations in these properties lead to changing the blood viscosity and, as a consequence, to changes in blood flow through capillaries. This can lead to significant impairment of blood function, which increases a risk of occurrence of vascular concomitant diseases, and even the mortality especially in the case of cardiovascular pathologies. In this work, complex studies of the factors determining the capillary blood flow in patients suffering from such a socially significant disease as arterial hypertension were conducted by optical methods. Light scattering laser aggregometer and diffractometer RheoScan AnD-300 (Rheomeditech, Korea) was used to conduct in vitro measurements of aggregation and deformability characteristics of the cells on ensembles of erythrocytes. Double-channeled optical tweezers were used for measuring the aggregation speed as well as interaction forces during erythrocyte doublet formation on cellular level. To quantitatively evaluate the capillary blood flow in vivo non-invasive capillaroscopy measurements in the nailfold vessels were conducted. In vitro measurements were performed with EDTA-stabilized human blood samples drawn from patients with arterial hypertension (AH) (70 people) and practically healthy volunteers – control (18 people). It was shown that in AH-patients, the ability of erythrocytes to deform is slightly reduced while the aggregation speed and forces of the cells interaction are significantly increased relative to the control group. In the case of AH, the blood microcirculation in nailfold capillaries is impaired as well.