POSTERS

P1- Effects of hypertrophy and strength weight training on resting levels and responses of hemorheological parameters to a single session of exercise

Fatholah Havil [a,b] , Afshar Jafari [a,c] , Sajad Ahmadizad [c] , Saeed Nikoukheslat [a]
[a] *Faculty of Sports Sciences, Tabriz University, Iran*
[b] *Department of Physical Education, Faculty of Imam Ali, Safadasht Branch, Technical and Vocational University, Iran*
[c] *Department of Biological Sciences in Sport and Health, Faculty of Sports Sciences and Health, Shahid Beheshti University, Iran*

Introduction: The present study was carried out to determine the effects of 12 weeks of two different resistance training programs on resting levels and responses of hemorheological factors to a single session of resistance exercise. Methods: Thirty nine male students were randomly divided into three groups of hypertrophy (n=14), maximal strength (n=13) and control (n=12). Hypertrophy resistance training program included 12 weeks of training, three times per week, 3-4 sets of 10-12 repetitions at 65-70% of one repetition of maximum (1-RM). The strength training program included 12 weeks of training, three times per week, 3-4 sets of 4-7 repetitions at 80-85% of 1-RM. Before and 48 hours after training, all subjects performed a single session of resistance exercise at 80% of 1-RM. Hemorheological variables were measured before and after the two acute exercise trials in the three groups. Results: Resting levels of blood and plasma viscosity reduced in hypertrophy group compared to both strength and control groups ($P<0.05$), while, red blood cell aggregation decreased and deformability increased significantly ($P<0.05$) in both training groups compared to the control group. Changes in resting levels of hematocrit, fibrinogen, total protein and albumin in training groups were not significantly different than control group ($P>0.05$). Except for RBC deformability, 12 weeks of resistance training did not induce any significant changes in responses of all other variables to acute resistance exercise ($P>0.05$). Conclusion: It is concluded that except for blood viscosity, hypertrophy and strength weight training improve all other hemorheological variables similarly, and that different types of weight training have no effect on acute hemorheological responses.

P2- Modulation of Erythrocyte Mechanical Function by Calcium-calmodulin-protein kinase C

Ali Cenk AKSU [a,b], Yasemin AKSU [b] , Dilan ATAR [b] Zeynep Busra Kısakurek [b] Elif Ugurel [b], Ozlem Yalcin [b]
[a] *Graduate School of Health Sciences, Turkey*
[b] *Koç Universit, Turkey*

Red blood cell (RBC) deformability has a vital importance for microcirculation as RBCs traverse narrow capillaries under shear stress. RBC deformability could be regulated with protein kinase C (PKC) cascade by phosphorylative changes in membrane proteins. The aim of this study is to investigate the role of Ca^{2+}-Calmodulin-PKC signaling pathway on RBC mechanical responses with the effect of Ca^{2+}.

Fresh venous blood samples were collected from healthy donors (n=7). Verapamil, Chelerythrine and Calpeptin drugs were used to inhibit Ca^{2+} channel, PKC and tyrosine phosphatase, respectively. The final concentration of drugs in blood was 10^{-5} M. Ca^{2+} was added in blood (3mM) alone or with the drugs. RBC deformability was measured as the change in the elongation index (EI) at different shear stresses (SS) (0.3-50 Pa) by a laser-assisted optical rotational cell analyzer (LORRCA). Shear stress at 5 Pa level was applied with the same device for 300 seconds and immediately deformability was measured again. Maximum RBC elongation at infinite stress (EI_{max}) and the shear stress required to achieve one-half of this maximal value ($SS_{1/2}$) were calculated from EI-SS curves by using Lineweaver-Burke (LB) model.

RBC deformability significantly increased by Verapamil ($p<0.05$), decreased by Calpeptin ($p<0.05$) and was not significantly changed by Chelerythrine before 5 Pa SS. Shear-induced RBC deformability was not significantly changed with drugs after SS application. Ca^{2+} deteriorated RBC deformability in all conditions with or without the effect of drugs.

Ca^{2+}-Calmodulin-PKC cascade might have a role on the regulation of RBC mechanical properties through phosphorylative changes in RBC membrane proteins and alterations in Ca^{2+} influx.

P3- Clinical relevance of hemodynamic viscosity measurement in vascular study

Tilly Alexandre
PISCO, France

The rheological behavior of whole blood has been of basic science and clinical interest, notably beginning with the work of Jean-Louis-Marie Poiseuille(1799-1869).

But most reports have focused on testing blood as a homogenous fluid, ignoring the presence of formed elements. Usually, RBCs are the most important formed elements that cause changes in blood viscosity but we show that Igs are even more poising the flow in case of sepsis chock.

We show experimental results of both normal and sepsis blood, and with plasma, not ignoring RBCs role.

The formation of a cell-poor or cell-free layer near the tube wall and modulation of this layer by RBC aggregation is the most important problem of hemodynamic viscosity. RBC aggregation far from the wall layer reduces resistance to flow but Igs increase the problem.

The conclusion is that hemodynamic viscosity is operational to study blood viscosity and flow and substitute old techniques that are too much approximative like sedimentation, hematocryte, agregation rate or Couette model.

Hemodynamic viscosity appears thus as a unique parameter that completes the whole blood equation pressure and flow rate.

According to the Poiseuille Law, blood viscosity is viewed as a key component of vascular resistance. Hhemodynamic viscosity causes a rise in wall shear stress, in flow pressure, which may stimulate endothelial cells to produce nitric oxide and cause vasodilation.

The role of vascular function is correlated to blood flow and hemodynamic viscosity. In diseases where vascular function is impaired (hypertension, coronary disease, etc.), any increase in hemodynamic viscosity is of poor prognosis even if it increases the risks for vaso-occlusive crises.

The lack of oxygenation is the first consequence in viscosity increase

P4 - Analysis of seismocardiographic signals by the discrete Chebyshev transform

Mikhail Basarab , Natalya Konnova
Bauman Moscow State Technical University, Russian Federation

Since seismiocardiographic (SCG) signals have complex time-frequency characteristics, one of the popular methods of their investigation is the wavelet analysis [1]. However, this powerful technique is computational expensive, especially in real-time processing. That is why it is interesting to apply traditional polynomial approximations which are successfully used, for example, for analysis of electrocardiographic (ECG) signals [2]. The aim of this work is the development of the new scheme to SCG signals approximation through the Discrete Chebyshev Transform (DChT) [3]. It does not require a segmentation of the signal into blocks coinciding with the cardiac cycle and it is possible to use long portions of SCG signals made of multiple cardiac cycles. The SCG filtration is based on the thresholding of significant coefficients. The performance of the proposed method was evaluated with the compression ratio (CR) and Percent Root square Difference (PRD). Chebyshev polynomials of up to the 256^{th} order were used for high quality approximation. The proposed method is very fast that makes it useful in the data communication in telemedicine. The results obtained are optimistic in terms of SCG signal reconstruction error at given compression rates.

References

1. A. Taebi and HA. Mansy, "Time-frequency distribution of seismocardiographic signals: A comparative study," Bioengineering, 2017, 4(2), 32.
2. R. Chaturvedi and Y. Yadav, "Analysis of ECG signal by Polynomial Approximation," International Journal on Recent and Innovation Trends in Computing and Communication, May 2014, 2 (5), pp. 1029-1033.
3. D. Tchiotsop and S. Ionita, "ECG Data Communication Using Chebyshev Polynomial Compression Methods," University of Pitesti, Romania, 2010.

P5 - Fetal growth retardation and oxygen delivery hemorheological predictors in hypertensive vs normotensive pregnant women.

Jean-Frederic Brun[a,b] Emmanuelle Varlet-Marie[c], Pierre Boulot[d], Bénédicte Marion[d], Céline Roques [d,] Eric Raynaud de Mauverger [a]
[a] *U1046 INSERM, UMR 9214 CNRS, Physiopathologie & Médecine Expérimentale du Cœur et des Muscles - PHYMEDEXP, Unité d'Explorations Métaboliques (CERAMM), Université de Montpellier,*
[b] *Département de Physiologie Clinique, Hôpital Lapeyronie CHRU Montpellier*
[c] *Institut des Biomolécules Max Mousseron (IBMM) UMR CNRS 5247, Université de Montpellier, Ecole Nationale Supérieure de Chimie de Montpellier;Laboratoire de Biophysique & Bio-Analyses, Faculté de Pharmacie, Université de Montpellier*
[d] *Université de Montpellier*
[d] *Institut des Biomolécules Max Mousseron (IBMM) UMR CNRS 5247, Université de Montpellier, Ecole Nationale Supérieure de Chimie de Montpellier*

Physiological modifications of blood rheology during pregnancy and their alterations in pregnant hypertensive women have been extensively studied in the 1980's. Since vascular resistance is higher in hypertensive pregnant women whose newborns are small for gestational age, we investigated in a personal database if growth retardation of newborns is related to the oxygen delivery index (ratio

hematocrit / blood viscosity) and to the difference between hematocrit and the prediction of its optimal valued based on Quemada's equation. A sample of 38 hypertensive pregnant women (age 29 yr±1) was compared with 64 controls matched for age and gestational age, studied at 35±1 weeks gestation, extracted from a larger series of 162 pregnant women. On the whole the hypertensive group gave birth to smaller children (p=0,014). Plasma viscosity correlated with blood pressure only in hypertensive women (r=0.403 p<0.05). The bell shaped curve of predicted optimal hematocrit of nonhypertensive pregnant women was similar to that of nononpregnant women, but in hypertensive women it was shifted toward higher values (p=0.07), and the predicted optimal hematocrit (but not the actual one) was correlated with systolic (r=0.349 p<0.001) and diastolic (r=0.218 p<0.05) blood pressure. The predicted optimal h/h was higher in hypertensive women whose newborns exhibited a low birth weight (p=0,03), resulting in a higher discrepancy between actual and model-predicted « ideal » values of h/h (p=0.03) and hematocrit (p=0.02) compared with the subgroup with no growth retardation. Therefore in hypertensive women whose newborns exhibited a low birth weight, hemorheological parameters predicting oxygen supply are shifted to lower values than predicted by the model.

P6 - Leg electrical resistance predicts venous blood viscosity and hematocrit.

Emmanuelle Varlet-Marie [a,b], Laurent Vachoud[c], Bénédicte Marion[a], Céline Roques[a], Marlène Richou[d], Eric Raynaud de Mauverger [e], Jean-Frederic Brun[e]

[a] *Institut des Biomolécules Max Mousseron (IBMM) UMR CNRS 5247, Université de Montpellier, Ecole Nationale Supérieure de Chimie de Montpellier;France*

[b] *Laboratoire de Biophysique & Bio-Analyses, Faculté de Pharmacie, Université de Montpellier*

[c] *Université de Montpellier, France*

[d] *U1046 INSERM, UMR 9214 CNRS, Physiopathologie & Mé (INSERM U1046), France*

[e] *U1046 INSERM, UMR 9214 CNRS, Physiopathologie & Médecine Expérimentale du Cœur et des Muscles - PHYMEDEXP, Unité d'Explorations Métaboliques (CERAMM), Université de Montpellier, Département de Physiologie Clinique, Hôpital Lapeyronie CHRU Montpellier,France*

We previously reported that whole body bioelectrical impedance analysis (BIA) measurements are correlated to some hemorheologic factors, suggesting a relationship between viscosity factors and electric properties of flowing blood not only in vitro but also in vivo. Recently we reported that with segmental BIA (analyzing the body considered as composed of 5 cylinders) predictive equations for various determinants of blood viscosity were closer than for the wole body. Another widely used BIA technique uses leg-to-leg impedance measurements so that two cylinders (the two legs) are analyzed. We investigated whether impedance measured with this technique (Tanita TBF-300) is also a predictor of blood viscosity factors. From viscometric measurements performed on venous blood drawn in recreative athletes over the range of shear rates 1 to 6000 s^{-1} (RHEOMETRE Anton Paar CP 50-1), we found a correlation between leg-leg resistance at 50 kHz (Rx[50kHz]) and blood viscosity at 1000 s^{-1} (h_{1000} = 0.0051 Rx[50kHz] + 1.3265; r=0,521 p=0,028 yielding a prediction of h_{1000} (Bland Altman plot : bias 0,05 [RANGE -0,24 ; 0,34]. Neither plasma viscosity nor the red cell rheology index « k » of Quemada's model are correlated with Rx[50kHz], but hematocrit (Hct) does (Hct (%)= 0,0217 Rx[50kHz] + 33.783 r=0.480 p=0.044) yielding a prediction of Hct (Bland Altman plot : bias -0,11, [range -1,67 ; 1,45]. The discrepancy between actual and predicted Hct is also correlated with resistance at 50 kHz (r=0.575 ; p=0.031) as does the discrepancy between actual and predicted Hct /viscosity ratio (r=-0.651 ; p=0.006). Therefore, as other previously studied methods, leg to leg BIA predicts viscosity, suggesting that blood rheology may influence the passage of an electric current in the legs.

P7 - The transient hyperviscosity syndrome of labor and delivery shifts the hemorheological profile toward a lower ability to deliver oxygen to tissues.

Jean-Frédéric Brun [a], Pierre Boulot [b] Emmanuelle Varlet-Marie [c,d], Bénédicte Marion [c], Céline Roques [c], Eric Raynaud de Mauverger [c]

[a] *U1046 INSERM, UMR 9214 CNRS, Physiopathologie & Médecine Expérimentale du Cœur et des Muscles - PHYMEDEXP , Unité d'Explorations Métaboliques (CERAMM), Université de Montpellier, Département de Physiologie Clinique, Hôpital Lapeyronie CHRU Montpellier, France*

[b] *Université de Montpellier,France*

[c] *Institut des Biomolécules Max Mousseron (IBMM) UMR CNRS 5247, Université de Montpellier, Ecole Nationale Supérieure de Chimie de Montpellier; France*

[d] *Laboratoire de Biophysique & Bio-Analyses, Faculté de Pharmacie, Université de Montpellier, Fraance*

Labor and delivery induce a transient hyperviscosity syndrome which is mainly due to a decrease in RBC flexibility, with no change in either hematocrit or plasma viscosity, and a decrease in red cell aggregation. We investigated whether these alterations modify the hemorheologic determinants of oxygen transfer modelized with the prediction of the 'optimal' hematocrit' (hct). In 80 pregnant women we measured blood viscosity, plasma viscosity and red blood cell (RBC) aggregation during labor (before and after 4 cm dilatation), during delivery, and during delivery of the placenta. Blood viscosity increases ($p<0.001$) with a peak during delivery, explained by an increase in RBC rigidity. The 'optimal' hematocrit' (hct) was assessed as previously reported with the reconstruction of bell-shaped curve of the « oxygen delivery index » hematocrit/viscosity ratio h/η according to the equation of Quemada. The hct resulting in the highest value of h/η on this curve was considered as the « theoretical optimal hematocrit ». Hematocrit was unchanged during labor and during delivery, and then decreased during delivery of the placenta. By contrast theoretical hematocrit increased during labor and decreased during delivery, and then increased again during delivery of the placenta, so that the discrepancy between actual and theoretical hematocrit (as well as the discrepancy between predicted and actual h/η) became minimal during delivery. Both actual and theoretical h/η were as usual closely related and exhibited a decrease during delivery. These results show that during delivery the hemorheological determinants of oxygen transfer predict a trend toward lower oxygen supply which is not fully compensated and may contribute to the increased risk of tissular anoxia in mother and newborn.

P8 - Studies of the chemically induced changes of the mechanical properties of murine RBCs with the use of Atomic Force Microscopy (AFM)

Katarzyna Bulat[a,] ,Jakub Dybas [a, b] , Aneta Blat [a], Mateusz Mardyla [a,c] Anna Rygula [a, b], Stefan Chłopicki [a,d], Małgorzata Baranska [a, b], Katarzyna M. Marzec [a, e]

[a] *Jagiellonian Centre for Experimental Therapeutics (JCET), Jagiellonian University, Poland*

[b] *Faculty of Chemistry, Jagiellonian University, Poland*

[c] *Faculty of Motor Rehabilitation, University School of Physical Education,Poland*

[d] *Chair of Pharmacology, Jagiellonian University Medical College,Poland*

[e] *Center for Medical Genomics (OMICRON) , Jagiellonian University Poland*

Atomic force microscopy (AFM) provides a real-space, three-dimensional (3D) image of a surface through the detection of an interaction between a sharp mechanical tip and the surface features. This technique allows researchers to view high resolution topographies of materials at the atomic or

molecular scale. AFM is also the source of information about local mechanical properties such as stiffness, viscoelasticity, hardness and adhesion. Such technique can be very useful for analysis of biological materials such as cells and tissues[1,2].

In this work, we have focused on studies of mechanical properties of murine red blood cells (RBCs) obtained from the healthy control and mice model of the advanced atherosclerosis. We present the results of the AFM investigations of RBCs stiffness, topography and adhesion changes characteristic for alteration and due to interaction of RBCs with fixative. Isolated mice RBCs were fixed with various concentrations of glutaraldehyde and the monolayer of the RBCs was prepared on CaF_2 windows and measured with the application of the DPFM and AC modes. All mechanical properties were measured for both, RBCs in buffer solution as well as for dried smears. Our preliminary results proof that AFM is a sensitive technique to study the alternations of murine RBCs membrane on the single cell level.

References:
1. K.M. Marzec, T.P. Wrobel, A. Rygula, E. Maslak, A. Jasztal, A. Fedorowicz, S. Chlopicki, M. Baranska, J. Biophotonics, 7 (2014) 744.
2. K.M. Marzec, A. Rygula, B.R. Wood, S. Chlopicki, M. Baranska, J. Raman Spectrosc. 46 (2015) 76.

Acknowledgments: This work was supported by the Polish National Science Centre (UMO-2016/23/B/ST4/00795).

P9 - Investigation on energy characteristic of red blood cell deformability: a quantitative analysis of extending and retracting curves based on Atomic force microscopy

Dong Chen , Xiang Wang
Chongqing University, China

Deformability is a fundamental property of the cells and tissues of living organisms, which is commonly detected to indicate the state of the cells. And the cell deformability usually depends on the methods that we used, which is easy to be confused. The present research is designed to explore the energy characteristic of red blood cell deformability, based on a quantitative analysis of extending-retracting curves acquired from atomic force microscopy. ATP-depleted red blood cell are prepared by treatment with free-glucose Ringer solution. Our results clearly show that the Youngs' modulus of erythrocyte is closely depended on the concentration of intracellular ATP. Using the software of Matlab, we get the area between the extending and retracting curves. Analysis of the control and ATP-depleted RBC demonstrated that the area could clearly differentiate between normal and ATP-depleted, which imply that ATP-depleted cause the decrease of RBC deformability. Our measures unveil that cell deformability is closely related to the state of intracellular energy, which can be characterized by cell passive deformation and active deformation. This research also will provide the theoretical basis for study the erythrocyte senescence, and give the evaluating to the red blood cells apoptosis, and also provide the health indicator for clinical blood transfusion in storage of blood.

P10 - Measurement of Glycocalyx Volume: An Unreliable Biomarker.

FitzRoy Curry[a] , Charles Michel [b]
[a] *University of California, Davis, USA*
[b] *Imperial College, London, United Kingdom*

One approach to evaluate changes in glycocalyx function in human subjects is measurement of a

glycocalyx volume as a biomarker. The glycocalyx volume is the difference between the combined volume of plasma and glycocalyx measured using a tracer dilution principle and a plasma volume estimated from the red cell volume and large vessel hematocrit. The assumptions in the dilution method are: 1) tracer concentration within the glycocalyx equals plasma concentration; (2) a first order decay curve accounts for any early loss of vascular tracer; (3) no preferential binding of tracer to the glycocalyx. Errors arise from the use of large vessel hematocrit as a measure of whole body hematocrit, and the use of tracers that do not conform to the assumptions of the dilution principle. For example, the plasma volume Vp, derived from red cell volume (Vc) and large vessel hematocrit (H_{LV}) is given by the relation: $Vp=Vc\ (Tp/Tc)[(100/H_{LV})-1]$ where Tp and Tc are transit times for plasma and red cells respectively. The relation predicts that an increase in plasma volume (3 to 3.5L) would be underestimated by 40% if red cell velocity relative to plasma was also increased by the volume expansion and Tp/Tc decreased from 0.9 to 0.85. Such errors in plasma volume are misinterpreted as variation in glycocalyx volume. Michel and Curry (Microcirculation16, 213:2009; also Chapters 2 and 3 of "Perioperative Fluid Management" edited by Farag and Kunz, Springer, 2016) have described additional errors in tracer dilution methods resulting from tracer heterogeneity, steric exclusion of tracer in the glycocalyx, and tracer binding. To date, estimates of whole body glycocalyx volume are confounded by other vascular changes and are unreliable biomarkers.

P11 - L-Arginine supplementation does not affect red blood cell properties during high intensity interval exercise in overweight men

Sajad Ahmadizad [a], Ali Daraei [a], Minoo Bassami[b] , Hiwa Rahmani [a]
[a] *Department of Biological Sciences in Sport and Health, Faculty of Sports Sciences and Health, Shahid Beheshti University, Iran*
[b] *Faculty of Sports Sciences, Allameh Tabataba'i University, Iran*

Purpose: The present study was designed to investigate the effects of L-Arginine supplementation prior to exercise on responses of red blood cell (RBC) properties to high intensity interval exercise (HIIE) in overweight individuals. Methods: Ten overweight male students participated voluntarily in the study and performed two HIIE trials with and without L-Arginine supplement in two separate weeks. After 3-min warm up at an intensity corresponding to 30% of vVO_2max, all subjects performed a HIIE protocol included 10 intervals of 3-min encompassed 1-min running at 100% of vVO_2max and 2-min active recovery at 40% of vVO_2max. In both trials, subjects consumed either L-Arginine or placebo 90-min prior to exercise. Three blood samples were taken before supplementation, after supplementation (immediately prior to exercise) and immediately after exercise; and were used to measure red blood cell properties including RBC aggregation, RBC deformability, hematocrit and hemoglobin. The data were compared by using repeated measures of ANOVA (2×3). Results: Data analyses revealed that HIIE protocol increased hematocrit, hemoglobin and lactate significantly ($P<0.05$), but had no significant effect on RBC aggregation, RBC deformability, and fibrinogen concentration. When data for two trials were compared no significant differences between the responses of RBC properties to two HIIE protocols were detected ($P>0.05$). Conclusions: Based on the findings of the present study, it could be concluded that although HIIE is a high intensity exercise protocol, the HIIE with the work to rest ratio of 1 to 2 does not change the RBC aggregation and deformability, and that L-Arginine consumption prior to HIIE does not lead to any improvement in RBC properties during HIIE in overweight men.

P12 - Resonance Raman spectroscopy in detection and differentiation of various hemoglobin derivatives inside packed human red blood cells

Jakub Dybas [a], Malgorzata Baranska [b] , Stefan Chlopicki [a] , Katarzyna M Marzec [a]
[a] Jagiellonian Centre for Experimental Therapeutics (JCET), Jagiellonian University, Poland
[b] Faculty of Chemistry, Jagiellonian University, Poland

Red blood cells (RBCs) are stored for transfusion inside polyvinyl chloride blood-bags up to 42 days. In this time numerous biochemical changes may occur lowering effectiveness of transfusion. Resonance Raman Spectroscopy (RRS) is a technique of molecular spectroscopy, which is a convenient tool to study biological samples, as the measurements can be done in water environment in nondestructive and free label manner.[1,2] This technique is especially unique in studies of hemoporphyrin, because of resonance Raman effect which causes the enhancement of the signal when proper excitation wavelength is used.

Here we presented that RRS combined with UV-Vis absorption spectroscopy allows us to obtain very fast information about Hb forms inside whole volume of the human RBCs sample, as well as to estimate the oxidation and the spin state of the centrally coordinated iron ion and the presence of ligands in axial positions. We have shown that RRS is able to differentiate and characterize not only typical forms of functional Hb, like oxyhemoglobin and deoxyhaemoglobin, but also various types of dysfunctional Hb such as different types of methemoglobins (metHb-H_2O, metHb-NO_2^-, metHb-CN), as well as hemichrome (bihistidine complex of Hb).

P13 - Effects of different rehabilitation models on the elongation index of erythrocytes, study of activity of chosen erythrocyte enzymes, and the level of glutathione in elderly women

Katarzyna Filar-Mierzwa, Anna Marchewka, Zbigniew Dąbrowski, Paulina Aleksander-Szymanowicz
University of Physical Education in Cracow, Poland

Introduction: Ageing has a considerable effect on the rheological properties of human blood. The aim of this study was to analyse the effects of two various rehabilitation protocols – dance movement therapy exercises (DMT) and general rehabilitation exercises (GRE) – on the elongation index of erythrocytes, study of activity of chosen erythrocyte enzymes, and the level of glutathione in elderly women.

Material and method: The study encompassed two groups of women (mean aged: 67 years), who were subjected to three-month rehabilitation programmes: DMT (n = 20) or GRE (n = 19). Blood samples from all the women were examined for their rheological and biochemical parameters both prior to the study and three months thereafter. Deformability of erythrocytes was determined using a laser rheometer SSD Rheometer-Rheodyne. Activity of acethylcholinesterase (AChE), gluco-6-phosphate dehydrogenase (G6PD) and level of reduced glutathione was determined in washed erythrocytes according to spectrophotometric method Beutler.

Results: DMT affected the rheological parameters of the blood in elderly women, improving the erythrocyte deformability at the lowest shear stress value. GRE reduced the erythrocyte deformability at shear stress values equalling 4.24 and 8.23. AChE and level of reduced glutathione are not affected by DMT and GRE. G6PD activity increased (1.642 ± 0.286 vs. 1.797 ± 0.285; $p=0.0358$) and reticulocytes count also (7.650 ± 3.543 vs. 12.95 ± 4.796; $p<0.0001$) after DMT.

Conclusions: DMT and GRE modulates erythrocyte deformability in elderly women. Some indicators are not affected by DMT and GRE in older women, suggesting the maintenance of homeostasis.

P14 - Effects of whole body vibration training on hemorheological blood indicators in young healthy women

Halina Gattner [a], Justyna Adamiak [b], Magdalena Kępińska [c], Anna Piotrowska [c], Olga Czerwińska-Ledwig [c], Sylwia Mętel [b], Wanda Pilch [c]

[a] *University of Physical Education in Krakow, Faculty of Physical Education and Sport, Doctoral Studies, Poland*
[b] *University of Physical Education in Krakow, Faculty of Motor Rehabilitation, Faculty of Physiotherapy, Department of Physical Medicine and Biological Renewal, Poland*
[c] *University of Physical Education in Krakow, Faculty of Motor Rehabilitation, Faculty of Cosmetology, Department of Biochemistry and Basics of Cosmetology, Poland*

Introduction: Vibrations have a stimulating effect on the cardiovascular system. The vibrations transmitted to the human body dilate the blood vessels, increase the blood perfusion through the tissues, so that the muscles are better provided with oxygen and nutrients. However, the changes in the rheological properties of blood under the influence of training on the vibrating platform have not been clearly described in the literature.

Aim of the study: The aim of the study was to assess the impact of whole body vibration training on hemorheological blood indicators in healthy, young and non-training women.

Material and methods: The study was attended by 10 female students of the University of Physical Education in Krakow aged 19 to 23. All women took part in 36 individual training sessions on the vibrating platform (3 times a week for 3 months). In the subjects, venous blood was collected twice - immediately before and after the last training. Using the LORCA device, the erythrocyte elongation index (EI) and erythrocyte aggregation indexes were determined, i.e. AMP - total aggregation, T1/2 - half time of total aggregation, AI - aggregation index. The haematological indicators such as RBC (red blood cell), haemoglobin, haematocrit, MCV (mean corpuscular volume), MCH (mean corpuscular hemoglobin) and MCHC (mean corpuscular hemoglobin concentration) were also determined.

Results: After completing the training in the studied women, there was a statistically significant increase in the AMP and EI indexes measured at shear stresses: 0.3; 0.58; 1.13 (Pa).

Conclusions: A three-month training on the vibrating platform causes favourable changes in the rheological properties of the blood. The increase in the elongation index results in better blood flow through the capillaries.

P15 - Evaluation of vascular effects of photodynamic therapy in skin microcirculation using different photosensitizers

Tatyana Grishacheva , Dinara Faizullina, Nickolay Petrishchev, Irina Mikhailova
Pavlov First Saint Petersburg State Medical University, Russian Federation

The effect of photodynamic therapy (PDT) is largely related to the effect on microvasculature (MV). The peculiarities of changes in tissue perfusion when using various photosensitizers (PS), differing in their physicochemical properties have not been studied sufficiently.

The goal of research was to study the effect of the PDT with PS of different chemical structures on the MV in the skin.

The study was carried out on 96 male rats. Used PS: chlorin e6 derivative - Radachlorin (RH) 5

mg/kg; Coproporphyrin (CP) 10 mg/kg; Bengal pink (BR) 17 mg/kg. We used semiconductor laser devices with wavelengths of 662, 635 and 530 nm. Irradiation modes: 1) power density-0.38 W/cm2, light dose-300 J/cm^2; 2) power density-0.1 W/cm^2, light dose-50 J/cm^2. Bloodflow was evaluated before, immediately and 1 hour after irradiation with a laser flowmeter. The administration of PS to rats did not lead to significant changes in bloodflow. An increase of perfusion of 13 and 15%, respectively ($p<0.05$) was observed in the red region (635 and 662 nm, 300 J/cm^2) an hour after irradiation, and when irradiated in the green region (530 nm, 300 J/cm^2) there was a decrease in perfusion of 23% ($p<0.05$).

Photoactivation of CP and BR by laser radiation (635 and 530 nm, respectively) at 300 J/cm^2 resulted in an improvement in the perfusion of 32 and 66% respectively ($p<0.05$). The experiments with RH and irradiation of 662 nm, the decrease in perfusion of 63 and 71% ($p <0.01$) occurred immediately after irradiation at both 50 and 300 J/cm^2.

The physicochemical properties of the PS used differ in a number of characteristics: the quantum yield of singlet oxygen in RH is 0.96; BR-0.76; CP-0.37. This can explain a more significant disturbance of the MV in the photodynamic action on the skin in experiments with RH.

P16 - Analysis of Flow and Thrombus Development Within PDMS Channels of Varying Geometry

Tice Harkins, Jeremey Myslowski, Keefe Manning
The Pennsylvania State University, USA

Cardiovascular disease is the number one cause of death in the United States, affecting over 600,000 people annually. Many cardiovascular diseases are thought to be caused by a microcirculatory dysfunction.The blood flow pathway, through an implant (e.g. ventricular assist device) and in microcirculation, is one of the known factors that contribute to clot formation. Understanding the micro-scale factors that cause thrombosis is of paramount importance. Few studies have examined flow patterns around geometric irregularities and their effect on coagulation. The goal of this study was to quantify the flow pathway and subsequent thrombus development in two PDMS channels. Each channel has a geometric irregularity (crevice or sudden expansion) to serve as a nidus of thrombus formation. In order to quantitatively measure flow at the micro scale, a particle image velocimetry system was coupled with an inverted epi-fluorescent microscope. Due to the nature of PIV, whole blood cannot be used as the fluid medium. A solution to this problem is the use of tracer-particle seeded ghost erythrocyte cells in which the hemoglobin and cellular components are removed preceding tracer particle impregnation. Preliminary data support the micro-particle image velocimetry system's (μPIV) ability to quantitatively measure flow. Results were compared to a computer COMSOL model under the same flow conditions. The experimental data validated the computational model. The data demonstrate the technique's ability to generate stable flows within each PDMS channel. Thrombus formation was confirmed using time-lapse, fluorescent images.

P17 - Measurement of blood viscosity by measuring flows in microfluidic channel

Hyeonji Hong , Eunseop Yeom
Pusan National University, Korea South

Blood contains plasma, red blood cell (RBC), white blood cell, platelet and various proteins. RBCs have a substantial role in the hemorheological characteristics. Increased blood viscosity significantly changes the flow resistance and wall shear stress(WSS) related with cardiovascular diseases. The

relation between the blood viscosity and circulatory diseases has been studied in many previous studies. The general viscometers require a relatively large amount of samples and repetitive experiment for the accuracy. To measure viscosity with a smaller amount, the microfluidic method using micro channel was proposed. It is conducted by monitoring pressure between sample and reference fluids at the downstream of a microchannel with two inlets. However, it is difficult to apply this method to unknown inlet flow conditions. This microfluidic measurement was conducted under the known inlet flow rate condition. Therefore, the present study measures flow rate by micro particle image velocimetry (PIV) and then obtain viscosity from the measured data. Flow rate in the microchannel was estimated by assuming velocity profiles represent mean value along its channel depth. To demonstrate the measurement accuracy of flow rate, injected flow rate was compared with the flow rates measured at both upstream and downstream of a T-shaped microchannel. Blood viscosity could be reasonably estimated according to shear rate by measuring the interfacial width and flow rate of blood flows. As a result, it can be used for the case of unknown flow rate such as ex vivo condition. This method would be useful for understanding the effects of hemorheological features on the cardiovascular diseases.

P18 - Repeated whole body cryotherapy treatments does not cause changes in hemorheological parameters in healthy people

Magdalena Kępińska [a], Zbigniew Szyguła [b], Zbigniew Dąbrowski [c]

[a] *Department of Biochemistry and Basics of Cosmetology at the University of Physical Education in Krakow, Poland*

[b] *Department of Sports Medicine and Human Nutrition, Faculty of Physical Education and Sport, University of Physical Education, Krakow, Poland*

[c] *Department of Clinical Rehabilitation, Faculty of Motor Rehabilitation, University of Physical Education, Krakow, Poland*

Study aim: The aim of the study was to examine the influence of systemic cryotherapy on the rheological properties of the blood.

Study material: The study groups consisted of 18healthy men, aged 19- 26, 10 students engaged in high-intensity physical activity and 8 students who engage in moderate-intensity physical activity participated in the research experiment. All subjects participated in 24 whole body cryotherapy (WBC) treatments (3 min treatment time, -120°C chamber temperature).

In order to analyze the rheological parameters of the blood, venous blood samples were drawn from the participants of the study nine times (before 1,12,24 and after 1,12, 24 WBC and after 24hrs after 1,12,24 WBC). Blood samples were also collected four times after the completed treatments of WBC (after 1,2,3,4 week break from the last treatment). RBC aggregation and deformability were measured at 37°C using a Laser assisted Optical Rotational Cell Analyzer (LORCA, RR Mechatronics, Hoorn, The Netherlands). Morphological blood test was obtained in a medical laboratory in Krakow.

Results: There were no significant changes after a single and after a series of WBC treatments in the elongation index (EI) in both study groups and in the aggregation of RBC also in both groups. A single WBC did not cause changes in the morphological properties of the blood in both groups. The biggest differences between the examined indicators were noticed after the series of WBC. The reduction of HGB, RBC levels and increase in MCV was the most noticeable. All obtained results were in the reference values.

Conclusions: WBC treatments does not increase the aggregation and deformability of red blood cells and thus does not increase the viscosity of the blood in healthy young, active males.

P19 - Correlation between certain biochemical plasma factors and rheological properties of white blood cells in stroke

Piotr Kowal
Department of Neurology, Poland

Basing on the analysis of correlations between rheological properties of white blood cells and certain biochemical plasma factors, in a group of 12 patients with acute ischaemic stroke, a positive correlation /$p<0,05$/ between the level of fibrinogen and the value of the relative filtration rate was determined.

For reological examination the St. George's Filtrometer /Carri Med., Dorking, England/ was used.

The result indicates that fibrinogen plays a role as a one of the factors decreasing white blood cell elasticity in the acute cerebral ischaemia

P20 - Cell volume regulation via the Calcium-activated Potassium channel KCa3.1 contributes to red blood cell compliance under shear

Jan Lennart Kuck [a] , Michael J. Simmonds [a,b]
[a] *Griffith University, Australia*
[b] *Biorheology Research Laboratory, Australia*

Background: Red blood cells (RBC) are exposed to varying magnitudes of shear stress (SS), resultant from varying vessel diameters of 2.5 μm - 25 mm, whilst traversing the cardiovascular system. Upon shear exposure, calcium enters the cell, most likely via the mechano-sensitive piezo1 channel. Intracellular calcium activates KCa3.1-mediated K^+-efflux and augments H_2O extrusion, thus reducing cell volume. It is thought that micro-volume regulation of cell hydration facilitates perfusion through the microcirculation and impacts RBC deformability.

Aim: The current study explored the effect of shear-induced calcium influx and subsequent Gardos-channel activation in RBC; corresponding changes in cellular deformability were also examined. Method: Whole blood from healthy, male volunteers (age: 22.5 ± 0.7 yr) was seperated by centrifugation (1500 x g, 5 min). Packed RBC were incubated with Senicapoc, a selective Gardos-channel blocker, at a final concentration of 10 nM, or phosphate buffered saline as Control at 37ºC for 20 min. RBC deformability was quantified in an ektacytometer, before and after, conditioning shear exposure, with cells suspended in isotonic polyvinylpyrrolidone solution containing distinct concentrations of $CaCl_2$ (0, 25 μM, 2 mM). Results: Shear-conditioning with 10 Pa increased cell deformability; this effect was amplified with blockade of the Gardos-channel. Exposure to 64 Pa SS significantly impaired cell deformability regardless of channel blockade. High extracellular calcium impaired cell deformability, although blockade of the Gardos-channel reduced this impairment. Conclusion: The Gardos-channel plays a significant role in the regulation of RBC deformability, which is dependent upon presence of extracellular Ca^{2+} and the magnitude of SS exposure.

P21 - Effects of rowing on rheological properties of blood

Mateusz Mardyła [a,b], Aneta Teległów [a] , Zbigniew Dąbrowski [a], Jakub Marchewka [a,c], Jacek Głodzik [a,d], Bartłomiej Ptaszek [a,d]
[a] *University School of Physical Education, Poland*
[b] *Jagiellonian Centre for Experimental Therapeutics, Poland*
[c] *5th Military Hospital, Poland*
[d] *Małopolska Cryotherapy Centre, Poland*

Rowing is one of the most challenging discipline where best athletes are characterized by excellent performance and factor that affect it such as power, force, technique and aerobic capacity. Rowing is strength-endurance sport where most energy produce to muscle work is obtain from aerobic transformation of carbohydrates and lipids. The aim of the study was to assess the changes in morphological-rheological properties of blood in female elite rowers at the beginning and after full competition season. In order to examine these changes, blood was collected twice, in January and in November. The study group consisted of 11 female rowers and 10 non-trained women. The qualified nurse collected blood from athletes in the Laboratory of Blood Physiology at the University School of Physical Education in Krakow. Calculation were performed using the Statistica 12 (StatSoft®, USA) software.

Our research lead that regular endurance training cause decrease in red blood cell count. However, the other properties such as mean corpuscular volume (MCV) and average mass of corpuscular hemoglobin (MCHC) was significant higher at athletes in comparison with non-trained subjects. Result of control group accord to norm determine by ICSH.

The biggest change occured in the plasma viscosity compered to untrained woman. This has possible reason in increase in plasma volume and relocation of the intracellular water. The lower elongation index on different shear stress in athletes indicate smaller deformability of red blood cell. The reason could be in bigger concentration of lactate in blood at rest compare to untrained subject. It could has explanation also in important role of free radicals production in exercise and its influence on red blood cell stiffness.

P22 - Impaired Deformability of Erythrocytes in Hypertensive Rats and Patients: Investigation by Nickel Mesh Filtration Technique

Toru Maruyama [a] , Keita Odashiro[a], Takehiko Fujino[b] , Shiro Mawatari[c]
[a] *Kyushu University, Japan*
[b] *BOOCS Clinic, Japan*
[c] *Institute of Rheological Function of Foods, Japan*

Abstrakt:

Background: Hypertension is associated with microcirculatory disturbance, and erythrocyte deformability is a major determinant of the microcirculation. Aim: The present study aimed to investigate the impairment of erythrocyte deformability in spontaneously hypertensive rats (SHR) and hypertensive patients under medication. Methods: Erythrocyte suspension was prepared after adjustment of hematocrit. Erythrocyte deformability was quantified as filterability by highly sensitive and quantitative filtration technique using nickel mesh. Wister-Kyoto rats (WKY) and normotensive subjects were served as controls. Results: In rats, erythrocyte filterability of SHR was significantly impaired than that of age-matched WKY. The impairment was marked in young (7 week) SHR and sustained in mature (18 week) SHR. In human, erythrocyte filterability in hypertensive group was significantly lower than that of the normotensive group. The filterability of hypertensive group was

inversely proportional to the mean blood pressure ($r = -0.303$, $p = 0.002$). This impairment could not be explained by erythrocytes features (mean corpuscular volume and hemoglobin concentration). Conclusions: Filterability of hypertensive erythrocytes is impaired, which is presumably caused by the mechanical membrane damage of circulating erythrocytes under the high shear stress and high blood pressure in the resistance vessels. Perspectives: Linkage of impaired deformability in hypertensive erythrocytes to target organ damage and hypertensive complications is a matter of future study.

P23 - Determinants of sublethal trauma to red blood cells: effects of shear rate at standardised shear stresses

Jacob Turner, Antony McNamee Jarod Horobin, Lennart Kuck, Kieran Richardson, Michael Simmonds
Biorheology Research Laboratory, Griffith University, Australia

Background: Red blood cell (RBC) deformation in shear is dependent upon the magnitude of shear stress exposure, and when levels become excessive, sublethal trauma is observed. Whether the corresponding shear rate contributes to sublethal trauma remains unresolved.

Aim: The present study explored the effect of exposing RBC to supraphysiological shear stress (64 Pa) in three different suspending media of specific viscosities, in an attempt to discern whether shear rate, independently, is a major determinant of sublethal trauma.

Method: RBC were suspended at 0.5 L/L in media of known viscosity (12.2, 20, or 29.6 cP). RBC deformability was assessed via ektacytometry at 37°C for all suspensions: i. without prior shear exposure (i.e., baseline), and ii. Following 64 Pa shear exposure for 300 s. Fresh samples were used for each measurement. Given diffraction patterns and maximal elongation of RBC are sensitive to viscosity, each diffraction pattern was standardised to a 10cm ellipse, and deformability measurements was expressed relative to the respective maximal elongation index (EI).

Results: Exposure to 64 Pa for 300 s decreased RBC deformability in all suspending media, with the most effect initially appearing in the highest shear rate suspension (i.e., 12.2 cP). Once deformability was standardised relative to maximal EI, however, it was found that the relative change in the 20 and 29.6 cP solutions (i.e., medium and low shear rate, respectively) displayed no significant differences following exposure to 64 Pa. Excessive artefact in the 12.2 cP sample precluded analyses of this data.

Conclusion: The present study demonstrated that sublethal trauma is primarily determined by the shear stress magnitude, independent of the corresponding shear rate.

P24 - Susceptibility to mechanical damage of density-fractionated red blood cells

Antony McNamee , Kieran Richardson, Lennart Kuck, Kai Robertson, Michael Simmonds
Biorheology Research Laboratory, Griffith University, Australia

Background: Cytoskeletal and cytosolic properties of red blood cells (RBC) undergo changes throughout the physiological ageing process. Given these physical properties determine the ability of RBC to deform in response to shear stress (SS), cellular ageing likely alters this process.

Aim: The present study investigated how physiological ageing of RBC altered the responses to mechanical stresses within the physiological and supraphysiological ranges.

Methods: RBC were density fractionated to provide ‘young’ and ‘old’ fractions, through

centrifugation at 1500 g × 300 s. Assessments of the fractionated cells included: i. osmotic gradient ektacytometry; and, ii. laser diffractometry to assess RBC deformability across a discrete range of SS (0.3–50.0 Pa). Specifically, RBC deformability was determined for fractionated populations without previous shear conditioning, and also immediately after 300 s of shear exposure to: i. 10 Pa ("physiological"), and ii. 64 Pa ("supraphysiological").

Results: Old RBC (i.e., most dense) exhibited significantly decreased deformability under all osmotic conditions compared to young cells (i.e., least dense). Both young and old RBC fractions displayed typical increases in cell deformability following 10 Pa shear conditioning, and decreased deformability following 64 Pa shear conditioning; however, the magnitude of decreased cell deformability in old RBC was disproportionate to that of young RBC.

Conclusion: Older RBC subpopulations exhibit decreased deformability and increased susceptibility to sublethal mechanical damage. These data may be of value in blood storage and transfusion processes.

P25- **Clinical Evaluation of Laser Doppler Flowmetry for diagnosis of microcirculatory disorders**

Christof Mrowietz[a], R.P. Franke[b], G. Pindur[c], R. Sternitzky[d], F. Jung[e] , U. Wolf [f]

[a] *ITTN, University of Veterinary Medicine, Hannover, Germany*

[b] *Central Institute for Biomedical Engineering, University Ulm, Germany*

[c] *Institute for Clin. Hemostasiol. and Transf. Medicine, University Saarland, Germany*

[d] *Praxisklinik Herz und Gefäße, Dresden, and BTU, Cottbus-Senftenberg, Germany*

[e] *Institute of Biomaterial Science and BCRT, HZG, Teltow, Germany*

[f] *University of Applied Science Fulda, Germany*

Background: Laser doppler flowmetry (LDF) is a noninvasive method used to study skin blood perfusion by measuring the flow of blood cells inside a volume without harming the tissue. The results of LDF measurements for the diagnosis of circulatory disorders of the skin are generally evaluated by comparisons between a reference population of apparently healthy and "pathological" subjects.

Methods: This study investigates the value of LDF in the diagnosis of microcirculation disorders in patients with coronary heart disease (n=20) and in patients diagnosed with microcirculation disorders by capillary microscopy (n=46).

Results: The average LD amplitudes for patients with coronary heart disease were in the reference range. Some patients however showed decreased LD values. In eleven of the twenty patients the average LD values were below the reference range. Four of the eleven patients showed pathologically decreased capillary erythrocyte velocities of very=0.09-0.21 [mm/s], while the other seven patients exhibited normal blood circulation at rest.

All patients with a microcirculatory disorder had one significantly pathologically reduced LD amplitude in one or more frequency window FF2 to FF4.

Conclusion: The DOP method is a noninvasive diagnosis technique for the reliable detection of microcirculatory disorders of the skin.

P26 - Erythrocytes aggregation index correlate with oxidative stress and hydrogen sulfide plasma concentration in diabetes mellitus

Agata Pietrzycka [a], Katarzyna Krzanowska [b], Przemysław Miarka [b], Władysław Sułowicz [b], Marcin Krzanowski [b]

[a] *Department of Pharmacobiology, Jagiellonian University, Medical College, Poland*

[b] *Chair and Department of Nephrology, Jagiellonian University, Medical College, Poland*

Protein glycation of cellular membranes may results in rheological changes of erythrocytes and vascular complications during diabetes mellitus (DM). High glucose produced a significant increase in oxidative stress and reduction in the levels of small antioxidants (reduced glutathione - GSH, ascorbate - FRASC) and enzyme activities (superoxide dismutase - SOD and ascorbate radical reductase – AFR). Hydrogen sulphide (H2S) has been found to counteract changes via regulation interference with adhesion molecules or antioxidant properties.

The aim of this study was to examine possible link between erythrocytes aggregation, advanced oxidation protein products (AOPPs), H2S level and antioxidants (GSH, FRASC, SOD, AFR), in patients with diagnosed diabetes mellitus.

Red blood cells aggregation was measured as microscopic aggregation index (MAI) proposed by the International Commission for Standardization in Hematology.

Results. It has been proven that chronically occurring hyperglycemia in diabetes affects negatively the rheological properties of RBCs, leading to the increase in the MAI. A correlation of the increase in MAI values with the increase in AOPPs and H2S concentrations were demonstrated. It was found marked and negative link between MAI and GSH, FRASC levels.

P27 - Effects of carboxylated multiwall carbon nanotubes on erythrocytes stability and functionality.

Mateusz Przetocki [a], Józef Korecki [a], Grzegorz Gajos [b], Leszek Stobiński [c], Krzysztof Matlak [a], Kvetoslava Burda [a]

[a] *Faculty of Physics and Applied Computer Science, AGH-University of Science and Technology, Poland*

[b] *John Paul II Hospital, Department of Coronary Disease, Poland*

[c] *Faculty of Chemical and Process Engineering, Warsaw University of Technology, Poland*

Carbon nanotubes due to their unique properties are interesting materials for electronics, nanotechnology, material science etc. In medicine they could be applied as drug containers and carriers. The aim of the study was to examine a potential toxicity of multiwall carbon nanotubes functionalized with carboxyl groups (MWCNTs-COOH) on red blood cells. Using optical microscopy, spectrophotometry and Mössbauer spectroscopy we investigated size and shape changes of erythrocytes, their stability and functionality resulting from MWCNTs-COOH action, respectively. We observed, that erythrocytes swelled and their shape became irregular in the presence of MWCNT-COOH. Osmotic resistance curves showed variable behavior and they strongly depended on the applied concentrations of MWCNTs-COOH. This suggests complex interaction of these carbon nanotubes with the membrane structures of red blood cells. Moreover, we found that MWCNTs-COOH could modify the affinity of hemoglobin to bind. O_2.

P28 - Influence of different rhythms sound wave to serotonin concentration in rats hippocampus

Yang Ren , Zhidan Deng, Xiang Wang
BME Department of Chongqing University, China

Background: In our study, we focused on the infuence of music to serotonin concentration variation in hippocampus. rhythm was another parameter needed. We hope our research could answer what kind of music is able to improve mind situation of different people.

Method: (1) Heart rates of SD rats were detected under anaesthesia and normal situation, calculated averages, set rhythms (300beats/min, 350beats/min, 400beats/min); (2) Made sound waves according to setting rhythms with Finale 2011 software; (3) Rats were grouped randomly. Some were received differenet sound waves under anaesthesia or normal situation, some were received nothing as control. (4) Left and right hippocampus were isolated from brains into tubes filled with 0.9% NaCl solution, weighed. Then ultrasonicated tissues and centrifigured. Supernatant was used to serotonin ELISA.

Conclusion: (1) Right and left hippocampus have different responds to same sound wave; (2) Under anaesthesia situation, right hippocampus from group received 300 beats/min sound wave secreted the most serotonin concentration, 0.202ng/(ml*mg); (3) Under normal situation, right hippocampus from group received 400 beats/min sound wave secreted the most serotonin concentration, 0.128ng/(ml*mg); (4) Nearer to the current heart rate under certain situation the sound wave rhythm received was, the more serotonin secreted.

P29 - Physical properties of erythrocytes improve in hemochromatosis patients with repeated venesection therapy

Kieran Richardson, Antony McNamee, Michael Simmonds
Griffith University/ Biorheology Research Laboratory, Australia

Background: Physical properties of red blood cells (RBC), including cell aggregation and deformability, are significantly impaired in individuals with hemochromatosis (HH). Although many of the complications associated with HH (e.g., endothelial dysfunction) may be attributed to impaired blood rheology, it remains unknown whether common therapies have an effect on the physical properties of RBC. Aims: The current study investigated whether venesection therapy, a common therapy in HH for normalising iron levels, alters hemorheological parameters. Methods: Blood samples (~450 mL) were collected from recently diagnosed HH patients who, at the time of recruitment, were receiving their first venesection treatment (n = 18; age = 60 yr; female = 11%). Additional blood samples (~450 mL each) were collected ~10.5 wk later following initial treatment, and ~6.3 wk after each individual's second treatment. RBC aggregation was measured via an aggregometer after 10-s at stasis (M_0) and after 10-s at low shear (i.e., 3 s^{-1}; M_1). RBC aggregation was measured for two conditions: i. at native haematocrit; and, ii. after haematocrit was standardised to 0.4 L/L. RBC aggregability was also measured in 3% dextran-70 at 0.4 L/L haematocrit. RBC deformability was measured using an ektacytometer. Results: Venesection significantly improved M_0 for both native (12.3 ± 24.3) and adjusted haematocrit (13.9 ± 27.4%) conditions. Additionally, M_1 improved in plasma at 0.4 L/L haematocrit (10.6 ± 27.0%), and also for RBC in dextran (18.0 ± 14.8%). Venesection treatment was also found to significantly improve RBC deformability. Conclusion: The findings of the present study indicate that routine venesection therapy is an effective method for improving the hemorheological impairments associated with HH.

P30 - Experimental Characterization of the Embolus Trapping Efficiency of the U.S. FDA Generic Inferior Vena Cava Filter

Joshua Riley [a], Nicole Price [a], Brent Craven [b], Kenneth Aycock [b], Keefe Manning [a]
[a] *Department of Biomedical Engineering, The Pennsylvania State University, USA*
[b] *Division of Applied Mechanics, Office of Science and Engineering Laboratories, Center for Devices and Radiological Health, U.S. Food and Drug Administration, USA*

Inferior vena cava (IVC) filters are placed to prevent pulmonary embolism in at-risk patients who cannot tolerate anticoagulation therapies. The objective of this study is to characterize the embolus trapping efficiency of the U.S. FDA generic IVC filter. The filter is made of nitinol and consists of 16 identical struts equally spaced in a conical fashion around the hub. Experiments were performed in an optically accessible anatomical model of the IVC with the filter placed in the infrarenal region. Nylon spheres (n=110, ρ=1.14 g/cm^3) of diameters 3.2 mm, 4.8 mm, and 6.4 mm and bovine whole blood spherical clots (n=100, ρ=1.10 g/cm^3) of diameters 3.5 mm, 4.8 mm, and 6.0 mm were injected into either the left or right iliac entrances for each trial. The Reynolds number was 1470 and the clot-to-fluid density ratio was approximately 1.02 for each trial. The trapping efficiency for the 3.2 mm diameter nylon spheres and 3.5 mm diameter blood emboli was approximately the same: ≈75% for emboli from the left iliac vein (45 total trials) and ≈10% for emboli from the right iliac vein (45 total trials). All of the larger 4.8 mm and 6.4 mm nylon spheres were captured (15 of 15 for each side), whereas the trapping efficiency of the 4.8 mm blood clots was 93% (14 of 15) from the left iliac vein and 66% (10 of 15) from the right iliac vein. The 6.0 mm blood clots were also captured with 100% efficiency (14 of 14 for each side). These results suggest that the trapping efficiency depends on embolus size, the iliac vein from which the embolus originates, and, in some cases, the embolus material. In future work, these results will be leveraged to validate a physics-based computational model of embolus transport and capture.

P31 - Effects of pentoxifylline on hemodynamic and hemorheological parameters in SHRs during arterial hypertension development

Alexander Shamanaev, Oleg Aliev, Anastasia Sidekhmenova, Anna Anischenko, Mark Plotnikov
Goldberg Research Institute of Pharmacology and Regenerative Medicine, Tomsk National Research Medical Center, Russian Academy of Sciences, Russian Federation

Blood viscosity is the one of the principal determinant of total peripheral resistance (TPR), and its increase contributes to some extent to developing of arterial hypertension. This means that there is a potential opportunity to reduce TPR and blood pressure (BP) by agents which directly improve the rheological properties of blood. Previously, it was shown that pentoxifylline (PTX) exerts a positive influence on hemorheological parameters, but it had no effect on hemodynamic parameters in spontaneously hypertensive rats (SHRs) with stable hypertension. The present study was aimed to investigate the effect of this agent administration on BP, TPR, and rheological parameters of blood in SHRs during the development of arterial hypertension. SHRs were treated intragastrically with PTX at a dose of 100 mg/kg for 6 weeks (from 5th to 11th week of life). In control SHRs BP increased steeply during this period with the progressive growth of TPR. In addition, an evident manifestation of hyperviscosity syndrome in SHRs aged 11 weeks was observed. By the end of the experiment, PTX-treated rats had lower BP (by 19%) and TPR (by 31%) compared with the control group ($p<0.05$), while cardiac output was unchanged. Hemorheological measurements showed that blood

viscosity at shear rates from 60 to 450 s^{-1} was significantly lower (by 4–6%) in PTX-treated animals. There was no effect on hematocrit, plasma viscosity and half-time of RBC aggregation, but RBC deformability was higher significantly (by 1.5–1.7%) compared to control SHRs. These results show that administration of PTX to young SHRs can attenuate the severity of hyperviscosity syndrome, which is probably why this agent managed to decrease TPR and, therefore, limit the BP increasing during the development of arterial hypertension.

P32 -Effect of cholesterol-rich diet on hematological and hemorheological parameters in rabbits

Bence Tanczos [a], Viktoria Somogyi [a], Mariann Bombicz [b], Bela Juhasz [b], Norbert Nemeth [a], Adam Deak [a]

[a] *Department of Operative Techniques and Surgical Research, Faculty of Medicine, University of Debrecen, Hungary*

[b] *Department of Pharmacology and Pharmacotherapy, Faculty of Medicine, University of Debrecen, Hungary*

Introduction: Little is known about the effect of cholesterol-rich diet on hemorheological factors. We aimed to investigate this issue on rabbits, as one of the best animal models in atherosclerosis research.

Materials and methods: California-New Zealand hybrid rabbits were subjected to two experimental groups: the control group animals (RCC, n=6) were fed with normal rabbit chow, while the rabbits in cholesterol-rich diet group (RHC, n=6) were fed with chow supplemented by 1% cholesterol and 1% triglyceride for 16 weeks ad libitum (permission Nr.: 25/2013/UDCAW). Blood samples were taken from the marginal ear vein into Vacutainer tubes containing K3-EDTA for determining hematological parameters, red blood cell deformability, membrane stability and aggregation.

Results: In the RHC group the white blood cell count ($p<0.001$) and mean corpuscular volume ($p=0.009$) increased, while the red blood cell count ($p<0.001$), hemoglobin ($p<0.001$) and hematocrit ($p<0.001$) decreased, with lowered blood viscosity. Erythrocyte deformability and membrane stability values were lower than the control data (EI at 3 Pa: $p<0.001$; EImax/SS1/2: $p=0.035$). Red blood cell aggregation parameters reflected lower aggregation (AI%: $p=0.021$, Amp: $p=0.002$, t1/2: $p<0.001$).

Conclusions: The 16-week cholesterol-rich diet resulted in significant changes in several hematological and hemorheological parameters. Red blood cell deformability impairment was significant, and probably due to the decreased hematocrit, erythrocyte aggregation markedly lowered. These micro-rheological changes may contribute to the development of microcirculatory alterations.

P33 - Changes in biochemical properties of the blood in winter swimmers.

Aneta Teległów [a], Jakub Marchewka [a], Anna Marchewka [a], Zbigniew Dąbrowski [a], Bartłomiej Ptaszek [b], Mateusz Mardyła [a]

[a] *University of Physical Education, Poland*

b *Malopolska Cryotherapy Centre, Poland*

The aim of this study was to assess the influence of regular immersions and swimming in cold water on blood biochemical properties of individuals voluntarily involved in such activities.

Winter swimmers are persons taking winter baths when the water temperature ranges from 1°C to 4°C. The participants belonged to the Cracow Society of Winter Swimmers “Kaloryfer” - "The Heaters". In order to investigate changes in the biochemical blood properties of people participating in the study, venous blood was collected and tested twice. The study took place at the Bagry lagoon,

at the beginning of the season in November 2015 and at the end of the season, in March 2016. The study group consisted of 11 men aged 30-50 years, 'walrusing' throughout the season from November to March.

The blood was collected by a qualified nurse under medical supervision. After collection, the blood was transported to the Maria Sklodowska-Curie Memorial Institute - Center of Oncology in Krakow and to the Department of Laboratory Diagnostics - "Diagnostyka" in Krakow.

All calculations were performed using the Statistica 12 (StatSoft®, USA) software.

We found that systematic winter swimming has impact on several biochemical and immune system parameters.

Electrolytes. Observed substantial decrease in sodium and chloride levels is possibly caused by several mechanisms. The most possible explanation of this phenomenon is diuretic-urine sodium loss. Increased diuresis after swimming leads to greater electrolytes loss with the urine.

Renal function tests. Winter swimming was connected with a downward tendency in urea levels which is consistent with previous findings.

Liver function tests. We found no significant changes in plasma enzymes such as AST, ALT, GGT and LDH after regular winter swimming.

P34 - The paraclinical evolution in diabetic hypertensive patients with increased abdominal circumference

Cornel Cezar TUDORICA [a] , Ana Maria Vintila [a] , Stefan Dragos Tudorica [b] , Mirela Gherghe [c]

[a] *Coltea Clinical Hospital, Romania*

[b] *University Hospital, Romania*

[c] *Fundeni Hospital, Romania*

Objective: to assess paraclinical evolution in patients with essential systemic hypertension, DM2±IHD and increased abdominal circumference

Method: 220 patients > 40 yrs, with SH+DM2 (<5 years), treated with OADs examined in the last 3 yrs.It was a retrospective study. All the patients with heart failure NYHA II-IV and coronary major events were excluded. In all patients were recorded retrospective data:clinic, blood tests (lipids, HbA1c, hs CRP), ECG, US. The patients were divided into two groups: the control group (n=106) with abdominal circumference <100 in men, 90 in women– and the study group (n=89): patients with abdominal circumference > 100 in men, 90 in women. In all patients were assessed LV function and rest heart rate. In both groups were included only pts with HR< 90b/min, in sinus rhythm and EF>55%.

Results:

The mean age was 58.7, 51.9% women. The patients from the two groups had the same profile of risk factors and associated comorbidities (except obesity)

In control group – medium abdominal circumference: 97.8 cm in men, 88.2 cm in women; average hs-CRP was 2.3 mg/L, and average rest HR was 71beats/min

In study group - medium abdominal circumference: 116.3 cm in men, 101.2 cm in women; average hs-CRP was 3.6 mg/L, and average rest HR was 79b/min

Conclusion: Increased abdominal circumference seems to influence the evolution of hypertensive diabetic patients±ischaemic heart disease and decreases the possibility of control of paraclinical parameters even if the clinical evolution of the subjects seems to be similar. May be it is important to check more often these parameters in people with increased abdominal circumference because could be an additional marker for impaired evolution of cardiovascular diseases. Further studies are needed to confirm.

P35 - Alterations of red blood cell deformability and mechanical stability by heat-treatment on animal blood samples

Gabor Varga, Adam Attila Matrai, Balazs Szabo, Viktoria Somogyi, Barbara Barath, Bence Tanczos, Norbert Nemeth

Department of Operative Techniques and Surgical Research, Faculty of Medicine, University of Debrecen, Hungary

The long-lastingly elevated body temperature caused by different reasons may alter hemodynamics and hemorheological parameters. However, literary data is scarcely available in this topic. Therefore, we investigate the effect of heat-treatment at normal or fever-ranged temperature on the micro-rheological parameters of erythrocytes in animal models.

Blood samples were obtained from 7 Sprague-Dawley rats and 6 Beagle dogs. The K3-EDTA anticoagulated samples were centrifuged (1000g, 10 minutes), and red blood cell - normal phosphate buffered saline suspensions (10%) were prepared. Every sample was subdivided into 3 aliquots and heat-treated for 10 minutes at 37, 40 or 43 °C. Conventional and osmotic gradient deformability as well as mechanical stability of erythrocytes were determined by ektacytometry.

Elongation index (EI) values were significantly lowered in the samples treated at 43°C than the 37 °C group ($p<0.01$), accompanied by altered ratio of maximal EI and the corresponding shear-stress values ($p<0.01$) in both species. Moreover, values at 43°C were significantly lower than those of 40°C ($p<0.01$) in rats. Changes in mechanical stability and osmotic gradient deformability parameters were also similar, but most markedly between the minimal and maximal elongation index values ($p<0.01$ 43^{o}C vs. 37^{o}C), and in the area under the curve ($p<0.001$ 43^{o}C vs. 37^{o}C) parameter.

Deformability of red blood cells significantly impaired by the applied heating in both species, showing slight inter-species differences as well. The deterioration was larger in magnitude when the temperature increased, however, the relation was non-linear. These data suggest that high fever may have an impact on the micro-rheological properties of erythrocytes that may further influence microcirculation.

P36 - Shear-dependency of the predicted ideal hematocrit

Emmanuelle Varlet-Marie [a,b], Laurent Vachoud [c], Bénédicte Marion [a], Céline Roques [a], Marlène Richou [d] , Eric Raynaud de Mauverger [d] , Jean-Frederic Brun [d]

[a] *Institut des Biomolécules Max Mousseron (IBMM) UMR CNRS 5247, Université de Montpellier Ecole Nationale Supérieure de Chimie de Montpellier, France*

[b] *Laboratoire de Biophysique & Bio-Analyses, Faculté de Pharmacie, Université de Montpellier, France*

[c] *Université de Montpellier, France*

[d] *U1046 INSERM, UMR 9214 CNRS Physiopathologie & Médecine Expérimentale du Cœur et des Muscles - PHYMEDEXP , Unité d'Explorations Métaboliques (CERAMM), Université de Montpellier, Département de Physiologie Clinique, Hôpital Lapeyronie CHRU Montpellier, France*

The ideal hematocrit is the hematocrit (hct) value resulting in the highest value of hct / viscosity (h/h) ratio and can thus be predicted from viscometric measurements with the use of equations such as Quemada's one which yield the determination of the bell-shaped curve of h/h as a function of hct. In a series of recent papers we applied this approach to various populations, using viscopetry at high shear rate (1000 s^{-1}). However the shape of this curve is dependent on the shear rate, resulting in a right-shift in this top value when hct increase, as previously described by Nemeth et al [Biorheology. 2009;46(2):155-65]. We present here in 11 young recreative athletes the evolution of the predicted

top of the h/h curve and optimal theoretical hct and the discrepancy between theoretical and optimal values over the range of shear rates 1 to 6000 s-1 (RHEOMETRE Anton Paar CP 50-1). Results show that the predicted optimal value of both h/h and Hct increases when shear rate increases when shear rate increases and that the discrepancy between predicted « optimal » and actual values decreases and becomes almost asymptotic at very high shear (500 s^{-1}). It is minimal at 2720 s^{-1}. The correlation between predicted « optimal » and actual values of both parameters describes the same evolution. Therefore, it is better for assessing h/h and its agreement with theoretical values, and for determining the theoretical ideal hematocrit, to measure blood viscosity at shear rates equal or superior to 500 s^{-1}.