P-11 – Dr. Henning Saupe, et al - Effect of rouleaux formation of erythrocytes in blood of patients treated by oncothermia

Oncothermia effect on rouleaux-aggregation of erythrocytes

Henning Saupe (1), Christian Buttner (1) & Gabor Andocs (2)

(1) Arkadia Klinik, Kassel, Germany

(2) Frederic Joliot Curie" National Research Institute for Radiobiology and Radiohygiene Budapest, Hungary

Objective

Observation and explanation of rouleaux phenomenon induce permanent debate started from its discovery. The aggregation of erythrocytes is a prominent feature in humans and other species "athletic" species [1]. In vitro studies have shown that aggregation of blood increases as shear rate decreases. Aggregation also depends on hematocrit and the concentration of macromolecules in the plasma or suspending medium [2], and in the presence of high molecular weight polymers, such as plasma proteins or dextrans, aggregate to form rouleaux and rouleaux networks [3]. However, the circumstances in which aggregation occurs is not well understood. Correlations of aggregation parameters with C-reactive protein and fibrinogen was proven in unstable angina, acute myocardial infarction, and bacterial infection [4] as well.
Our aim in this paper is to describe the systemic observations of blood samples before and after oncothermia, trying to clarify the oncothermia effect on blood.

Method

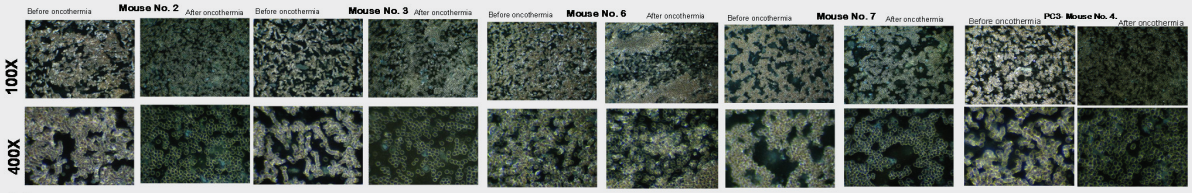
Blood samples of nude mice were studied before and after oncothermia treatment. The mice (Balb/C nu/nu) were xenografted by human HT-29 colorectal carcinoma cell-line in their both femoral regions symmetrically hetrotopic subcutaneous. The electrode was the most modern flexible arrangement, the applied power spectrum and the temperature plot are shown on the figures. The set of mice (ten animals) and the treatment device are shown for reference. Oncothermia treatment was done on mice for 30 minutes, single shoot reaching and keeping constantly 40 C in the tumor, while the other tumor (always the left one) was not treated, was studied as reference (modelling a not treated distant metastasis on the animal.)

Blood samples from voluntary humans also was collected. The human donors had suffered various malignant diseases. Blood samples of mice were carefully collected from tail's venue (venipuncture in tail vein) of mice under anaesthesia. The human samples were obtained from finger capillaries. Samples of venous blood from humans were collected also for comparison. The individual blood-collection was made immediately before and immediately after oncothermia treatment, as well as systemically performed in subsequent treatments in humans. Samples were promptly (freshly) measured by dark-field microscopy (slide-holder table was not heated). The pictures were archived by high resolution photo- or video-techniques.

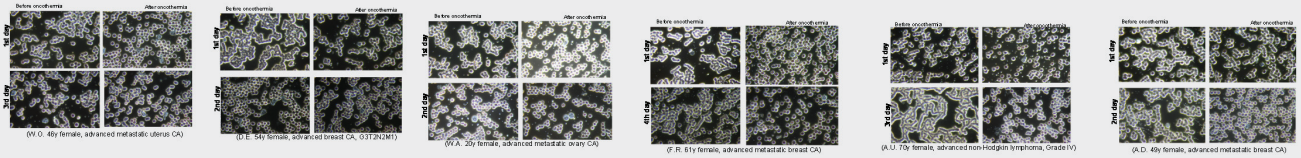
Results

Before the treatments the rouleaux formation of blood samples characteristically was observed in majority of the human individuals and 40% of the investigated animals. In all the cases, when the rouleaux formation was shown, oncothermia treatment has changed the roulleaux grouping, and the samples were mostly free of erythrocyte aggregates. These phenomena were independent of the treatment localization and also from the venous or arterial origin of the blood sample, and were observed both in humans and mice.

Mice



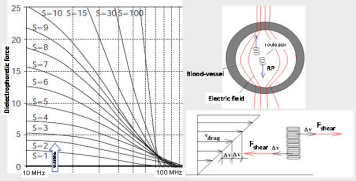
Humans

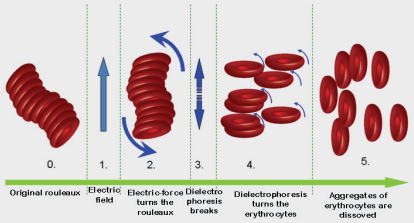


Discussion

The distortion of the erythrocyte aggregates could be well discussed by the action of the **dielectrophoretic forces.** The rouleaux are dielectric particles in aqueous electrolyte. The inhomogeneous field polarizes it together with its host matrix – the electrolyte. The polarization creates different charges in the ends of the rouleaux-chain, as well as in the electrolyte (Fig..). The movement of the RP depends on the charge values in its ends and in the host electrolyte.

Rules –
Dielectrophoretic force has some specialties in 13.56 MHz region [8]
1.maximal polarization exists in the axis of the rouleaux,
2.the dielectrophoretic force grows with the length of rouleaux,
3.the rouleaux fixes its direction from low filed-strength to high one,
4.the maximal polarizing direction in short rouleaux is radial.





The effect of oncothermia based on the rules above. The long rouleaux directs itself to the field-direction (rule 1.), and move from the cork-flow to the shear flow region (rule 3.). This tendency is gained by the length of rouleaux (rule 2.). In the region of shear-flow (Newton's flow) the middle of the rouleaux move with speed v_{drag}. Consequently its ends have opposite drag-forces and on this way the shear destroys the long rouleaux, (see Fig. . The satisfactorily small parts of the destroyed rouleaux turn perpendicular with their axis to the outside filed, so they have no further distortions (rule 4.).

Conclusion

In blood specimens where the rouleaux formation of the erythrocytes were observed, oncothermia dissolved the aggregates. Measurement of the oncothermia effect on rouleaux phenomena could lead us a simple control of the treatment efficacy, but our present data are not eligible for definite conclusions.

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