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On-line in-vivo measurement of blood viscosity by using a central venous catheter with electrical impedance technique

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The clinical significance of blood viscosity is based on several aspects: in the microcirculation it contributes significantly to the peripheral resistance and it may cause sludging in the post-capillary venules. It plays a pivotal role in the pathophysiology of atherosclerosis; at sites of low shear in the vascular tree initial plaque formation is due to increased blood viscosity. Finally, increased blood viscosity is often a marker of increased inflammatory activity and often leads to the formation of thrombi. Considering its clinical importance, we developed a technique to measure blood viscosity on-line in-vivo by using a dedicated biosensor on a central venous catheter. Furthermore, interface electronics and data processing software were integrated. The system was optimized to perform the electrical analysis of whole blood in the range from 20 kHz to 1, 2 MHz by using a four-electrode impedance sensor. This approach detects haematocrit and whole blood viscosity by measuring plasma resistance Rp and cell membrane capacitance Cm respectively. The impedance sensor, which is positioned inside the right atrium, captures the intracardiac ECG as well. The Rp and Cm measurements are synchronized with the detected ECG signal and are taken ideally at the end of diastole to measure blood viscosity at similar shear rates. In a clinical study in out-of-hospital cardiac arrest survivors, we validated the feasibility of this central venous catheter technique and demonstrated that cerebral blood flow was highly correlated with the viscosity of blood. This bio-impedance technique may help to define the optimal blood viscosity level in different clinical situations, which will guide therapeutic interventions.

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