Oscillatory microfluidic thromboelastograph (micro-TEG) analysis of whole blood coagulation and fibrinolysis

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ABSTRACT

Understanding of blood coagulation and fibrinolysis is critical for the management of patients who suffer from coagulopathies and need anticoagulation therapy. Conventional thromboelastograph (μ-TEG) analysis provided direct information including R-time, K-time, angle, MA and L30, which can help identify the hypercoagulable, hemorrhagic or fibrinoltic characteristic of blood samples. However, the shear environments of TEG assays are somewhat different from in-vivo hemodynamic shear flow.

We introduce an innovative approach, microfluidic thromboelastography (μ-TEG) that measures the viscoelastic properties of coagulating blood in a linear tube. When periodic oscillatory pressure is applied, anticoagulant blood periodically travels back and forth a certain distance. The variation of reciprocating distance (amplitude) is monitored with a video or pressure sensor and analyzed. The period of a cycle is 10 seconds (0.1 Hz), tube diameter is 1.5 mm, the blood sample volume ranges 5 – 50 μL depending on tube diameter and length. A typical length of blood filled in a tube is 20 mm.

When the blood is mixed with CaCl2 and kaolin, the reciprocating amplitude gradually decreased, showed a minimum value, and then slightly increased again. The obtained results using the newly developed μ-TEG system were analyzed and TEG variables including R-time, K-time, angle, MA and L30 within 10 min. We found that the μ-TEG system can observe the fibrinolysis phenomenon faster and more reliably compared to the existing TEG equipment, thereby reducing the experimental time innovatively.

The results of the present study suggest that μ-TEG would be a useful tool in blood clotting research, being capable of providing a global hemostasis profile in addition to detecting the instant of incipient clot formation. Additionally, due to the rapid assessment of a patient's coagulation status, the μ-TEG highlights the potential for point-of-care use.