Acoustic Rheology for Viscoelastic Soft Materials

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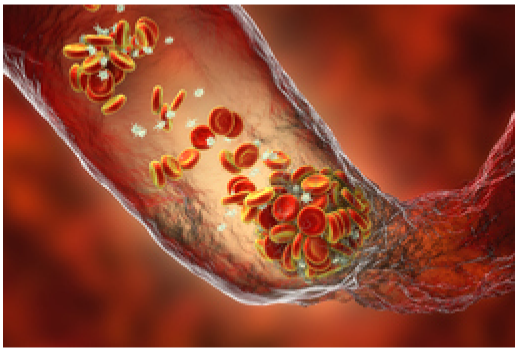

OVERVIEW

A novel means by which to measure resonant surface waves in liquids and soft materials

- Enables the rapid measurement of blood clot stiffness during formation and over time
- An approach which is non-invasive and non-destructive to maximize safety

BACKGROUND

Abnormal blood clot stiffness is a critical indicator of pathologies ranging from coronary artery disease to diabetes, and it serves as a potential metric to track the effectiveness of heparin treatment following major cardiovascular surgeries. As a tissue becomes harder due to forces such as tumor formation or cirrhosis of the liver, it becomes less resistant to deformations and indicates a pathological state. Elastography is the name of the type of measurement that assesses tissue elasticity or the tendency of a tissue to resist deformation. Clinical situations such as cardiopulmonary bypass and heart transplant surgeries require dose dependent heparin anticoagulation to avoid post-surgical complications such as those caused by clot formation.

The management of heparin dosing is still largely determined by activated coagulation time, a method with poor sensitivity and a lack of correlation with heparin level disparities in the postoperative setting. Clot stiffness, or clot elastic modulus (CEM), has emerged as a promising metric for hemostasis which is regulated by the availability of its constituent proteins, fibrin, platelets, and erythrocytes. Despite the usefulness of measuring clot stiffness, there are few existing devices which accurately measure and quantify changes in a clot's viscoelastic properties. Whereas multiple devices can visually measure and represent stiffness, few provide quantifiable information that can inform clinical treatment options. Given the high prevalence of

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cardiovascular diseases, the need exists for a device that can rapidly track and quantify blood clot thickness over time for patients within the hospital and primary care centers.

INNOVATION

Researchers at the University of Michigan have developed a technique for the generation and tracking of resonant surface waves in liquids and soft materials. The device consists of a transducer that generates ultrasonic pulses, detects resulting oscillations, and calculates viscoelastic properties of the biomaterial. Echo waveforms are stored during the measurements and are used to calculate the displacement of the sample surface as a function of time. The device has been tested across a wide range of soft biomaterial elasticities and shows consistent readings. This analysis enables the rapid measurement of blood clot stiffness, enabling clinicians to predict the progression of cardiovascular diseases and the response to heparin treatment following cardiovascular surgeries. Currently, few options exist to monitor clot stiffness at the early stages of pathology. This approach is non-invasive and non-destructive, allowing for dynamic tracking of material properties at a variety of time scales. The current technology could enable clinicians to detect and treat blood clotting technology in its early stages.