 Proceedings of ICCES'08, pp.673-673

Rheological and Optical-based Characterisation of the Fractal Structure of Fibrin Clot Networks

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We report studies of the microstructural characteristics of the three-dimensional fibrin 'clot' networks at physiologically relevant concentrations and temperatures measured using an oscillatory shear technique known as Fourier Transform Mechanical Spectroscopy (FTMS) and optical-based techniques including Confocal Laser Scanning Microscopy.

Both techniques provide a foundation for performing fractal analysis as a quantitative basis for defining, where appropriate, morphological/microstructural differentiation in clotting. Fractal analysis provides the framework for structural complexity and allows us to develop relationships between the structural features of fibrin clots and their rheological properties. With the establishment of fractal dimensions from rheological methods, we consider the validity for quantifying fibrin clots using fractal analysis for Confocal Laser Scanning Microscopy techniques.

In the present work we report results based on fractal analysis of fibrin networks formed by the addition of thrombin to fluorescently labelled samples of fibrinogen. We image the structural evolution of the fibrin clot using Confocal Laser Scanning Microscopy and quantify the structure of the clot in terms of a Fractal Dimension deduced from box counting and information estimation methods. Concurrently, we employ FTMS to monitor the evolution of viscoelasticity of the Fibrin clot and apply appropriate Fractal analysis to the FTMS data to yield a Fractal Dimension at the incipient clot network which is compared to that obtained from the image analysis.

The results of the present study suggest that FTMS is a useful tool in Fractal analysis, being capable of providing a precise measure of Fractal Dimension, which allows us to evaluate various methods of image analysis of Fibrin clots.