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Modeling the mechanical properties of liver fibrosis in rats

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Abstract: The progression of liver fibrosis changes the biomechanical properties of liver tissue. This study characterized and compared different liver fibrosis stages in rats in terms of viscoelasticity. Three viscoelastic models, the Voigt, Maxwell, and Zener models, were applied to experimental data from rheometer tests and then the elasticity and viscosity were estimated for each fibrosis stage. The study found that both elasticity and viscosity are correlated with the various stages of liver fibrosis. The study revealed that the Zener model is the optimal model for describing the mechanical properties of each fibrosis stage, but there is no significant difference between the Zener and Voigt models in their performance on liver fibrosis staging. Therefore the Voigt model can still be effectively used for liver fibrosis grading.

Key words: Mechanical Properties, Liver Fibrosis, Viscoelasticity, Complex Modulus, Elasticity, Viscosity, Voigt model, Maxwell model, Zener model

1 Introduction

The immune system of liver tissue is activated when the organ invaded by various pathogens that damage and inflame it. Liver fibrosis, which refers to the accumulation of extracellular matrix (ECM) proteins, is the result of a repairing process of the damaged tissue. The progression of liver fibrosis is an extremely complicated and gradual process. Currently a liver biospy is the only gold standard for the diagnosis of liver fibrosis. According to the METAVIR scoring system, fibrosis staging has been evaluated as: F0 representing no fibrosis; F1 representing portal fibrosis without septae; F2 representing portal fibrosis and few septae; F3 representing