Tentative Title: A Finite Element Analysis of Drop Tower Testing on Human Livers

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Abstract:

Abdominal injuries caused by motor vehicle crashes have a high severity, since they have an elevated potential to be life threatening. Yet to date, injuries in the abdominal region are poorly understood. The objective of this research is to perform a computational study to investigate the influence of the human liver's anatomical geometry, nonlinearity, viscoelasticity, and anisotropy on the macroscopic response of a liver exposed to known loading conditions at high strain rates. The influence that the fibrous Glisson's capsule has on the liver's overall behavior is also investigated, since it is neglected by many current FEM analyses. A previous study of human liver tissue, by Sparks et al. (2007), has been conducted by removing the organ from a post-mortem human subject to perform traditional engineering material tests. Using a Finite Element Modeling (FEM) software package, an axisymmetric FEM was constructed to simulate the experimental setup of Sparks et al. The FEM material properties were iteratively determined in order to match the experimental force-displacement data. A secondary validation was achieved from comparing experimental localized pressure measurements to the FEM pressure contour. The results to date indicate that the viscoelastic behavior of the liver does not significantly contribute to the overall response of the liver at high strain rates, using a hyperelastic material model versus a linear elastic material model only results in minor differences, and the inclusion of Glisson's capsule in the FEM changes macroscopic response considerably. Future simulations will use anatomical 3-D geometry to correlate observed failure locations with stress measures from simulation. The future objective of this research is to investigate the technique of cavitation to develop an apparatus that captures material measurements in-situ, placing emphasis on capturing the liver's material properties.