Effect of Postmortem Time and Preservation Fluid on the Tensile Material Properties of Bovine Liver Parenchyma

K. M. Dunford[1] and A.R. Kemper[1]
[1] Center for Injury Biomechanics, Virginia Tech - Wake Forest University

ABSTRACT

The liver is one of the most frequently injured abdominal organs in motor vehicle collisions (MVCs). However, currently accepted anthropomorphic test devices are unable to predict abdominal organ injury risk. Consequently, finite element models are becoming an important tool for assessing abdominal organ injury risk in MVCs. However, in order to accurately assess injury risk, these models must be validated based on biomechanical data. Previous studies have quantified the tensile failure properties of human liver parenchyma, but have been limited to testing at 48hrs postmortem. Although a previous study found no significant changes in the tensile failure stress or strain of bovine liver between 6 and 48 hours postmortem when the tissue was stored in DMEM, the effects of postmortem degradation may vary with respect to the type of preservation fluid used. Therefore, the purpose of this study was to quantify the effects of postmortem degradation on the tensile material properties of bovine liver parenchyma with increasing postmortem time when stored in saline and then compare the effects of saline versus DMEM on material property degradation. Uniaxial tension tests were conducted on parenchyma samples of five bovine livers acquired immediately after death. Tissue was immersed in normal saline and kept cool (i.e., never frozen) during preparation and storage. Multiple dog-bone samples from each liver were tested once to failure at three time points: ~6hrs, 24hrs, and 48hrs after death. The data were then analyzed using a Block ANOVA to determine if there were significant changes in the failure stress and failure strain with respect to postmortem time. The average failure stresses were 50.4±12.9kPa, 55.3±15.6kPa, and 54.7±22.0kPa at the 6hr, 24hr, and 48hr time points, respectively. The average failure strains were 0.28±0.023, 0.25±0.025, and 0.24±0.013, at the 6hr, 24hr, and 48hr time points, respectively. The results of the current study show that the failure strain of bovine liver parenchyma decreases significantly between 6hrs and 48hrs after death when stored in saline and refrigerated. Conversely, neither the failure stress nor failure strain changed significantly with respect to postmortem time when stored in DMEM. Overall, this study illustrates that the effects of postmortem liver degradation varies with respect to the preservation fluid. Specifically, DMEM was found to preserve the material properties of liver parenchyma more effectively than saline within the first 48hrs postmortem.